

SIGNAL SECTION ADVANCE NOTICE

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REPORTS

to be presented at the
Fiftieth Annual Meeting

BUFFALO, N. Y.

September 14, 15 and 16, 1948

RULES OF ORDER

RESULT OF 1947 LETTER BALLOT

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ASSOCIATION OF AMERICAN RAILROADS
SIGNAL SECTION

COMMITTEE REPORTS

1947 Fiscal Year
(September 13, 1947—September 16, 1948)

Fiftieth Annual Meeting
Hotel Statler
Buffalo, N. Y.
September 14, 15 and 16, 1948

The Committee of Direction suggests that papers of interest to the Signal Section be forwarded to the Secretary. They will be submitted to the proper committee for approval and printing in the literature.

ASSOCIATION OF AMERICAN RAILROADS

OPERATIONS AND MAINTENANCE DEPARTMENT

ENGINEERING DIVISION

SIGNAL SECTION

Office of the Secretary, 30 Vesey Street, New York 7, N. Y.

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Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Report on the economics of railway signaling.

The Committee submits for consideration, reports on the following subjects**:

3. Alternating current-primary battery with automatic rectifiers for track circuits—Economic results.

Summary of reports prepared by Committee I in connection with the economics of alternating current-primary battery for various signal applications.

Method for determining variation of freight train time saving due to improved signaling with varying train density.

Economics of siding signaling.

Formulae for estimating train miles saved due to increased tonnage with centralized traffic control.

Reduction in sidings on single-track lines with centralized traffic control operation.

Economics of automatic OSing systems.

Train hour value.

Installations of train operation by signal indication without train orders, in the United States, January 1, 1948.

Types of protection at railroad highway grade crossings, December 31, 1944 and 1945.

* Consulting Member.

** Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 17, 1948.

Crossings equipped with gates, watchmen and signals, December 31, 1945.

Interlockings in the United States, January 1, 1948.

Centralized traffic control installations in the United States and Canada, January 1, 1948.

Economics of use of capacitors in signal power lines.

Economics of eliminating signal line wire.

Freight train time saved where trains are operated by signal indication.

Economics of use of yard track indicators.

Economics of centralized traffic control between Las Vegas and Caliente, Nev., Union Pacific R.R.

ALTERNATING CURRENT-PRIMARY BATTERY WITH AUTOMATIC RECTIFIERS FOR TRACK CIRCUITS—ECONOMIC RESULTS*

The 120 installations on the reporting railroad were in territory where alternating current power was available in the housing where the track battery was located, requiring only the installation of the rectifier and necessary connections. Automatic rectifiers were used. Normal drain to track was set at 0.010 ampere per cell of battery. During track occupancy the drain rose to approximately 0.015 ampere per cell. Under primary operation average life of renewals was 240 days.

Comparative Statement

Item	A.C.- primary battery	Primary battery	Difference
Number of track circuits.....	120	120	0
Number of cells per track circuit.....	3	3	0
Average life of primary cells, days.....	1,736	240	1,496
Total number of primary cells.....	360	360	0
Cost per renewal.....	\$1.54	\$1.54	0
Power cost per annum per track circuit.....	\$0.21†	0	\$0.21
Annual cost of renewals per track circuit.....	\$0.972	\$7.02	\$6.05
Total annual cost of operation.....	\$1.18	\$7.02	\$5.84
Additional cost account of a.c. apparatus..	\$61.00	0	\$61.00

† 6.059 k.w.h. @ \$0.035 = \$0.21

Economic Statement

1. Increased Cost of a.c.-primary over primary Installation.....	\$7,320.00
2. Gross Saving per Annum by use of a.c.-primary.....	\$ 701.00
3. Interest (5% of Item 1).....	366.00
4. Net Saving per Annum.....	\$ 335.00
5. Annual Return over 5% Interest.....	4.6%

The 120 installations on the reporting railroad were in territory where alternating current power was available in the housing where the track battery was located, requiring only the installation of the rectifier and necessary connections.

* Previous report on this subject appears in A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, p. 7.

tions. Automatic rectifiers were used. Normal drain to track was set at 0.010 ampere per cell of battery. During track occupancy the drain rose to approximately 0.015 ampere per cell. Under primary operation average life of renewals was 60 days.

Comparative Statement

Item	A.C.- primary battery	Primary battery	Difference
Number of track circuits.....	120	120	0
Number of cells per track circuit.....	3	3	0
Average life of primary cells, days.....	1,736	60	1,676
Total number of primary cells.....	360	360	0
Cost per renewal.....	\$1.54	\$1.54	0
Power cost per annum per track circuit.....	\$0.81†	0	\$0.81
Annual cost of renewals per track circuit ..	\$0.972	\$28.10	\$27.13
Total annual cost of operation.....	\$1.78	\$28.10	\$26.32
Additional cost account of a.c. apparatus..	\$61.00	0	\$61.00

† 23.11 k.w.h. @ \$0.035 = \$0.81

Economic Statement

1. Increased Cost of a.c.-primary over primary Installation.....	\$7,320.00
2. Gross Saving per Annum by use of a.c.-primary.....	\$3,158.00
3. Interest (5% of Item 1).....	366.00
4. Net Saving per Annum.....	\$2,792.00
5. Annual Return over 5% Interest.....	38.1%

Action Recommended

Acceptance as information.

SUMMARY OF REPORTS PREPARED BY COMMITTEE I IN
CONNECTION WITH THE ECONOMICS OF ALTERNATING
CURRENT-PRIMARY BATTERY FOR VARIOUS
SIGNAL APPLICATIONS

During the past 5 years Committee I has presented 14 separate reports in connection with alternating current primary, involving 1,600 installations. Of these, 1,598 involved the use of rectifiers, both automatic and non-automatic, and two involved the use of power-off relays only. In all cases the installations involved the application of commercial alternating current to signal apparatus to extend the life of primary batteries. Of the 1,598 installations involving the use of rectifiers, 1,584 were on track circuits and 14 on other applications, such as color light or motor signals. Of the 1,584 track circuit installations, 524 used automatic rectifiers and 1,060 used non-automatic rectifiers.

The annual returns on first cost, over and above interest charges, varied from 2.7 to 356.5 per cent, the latter being a color light block signal with position light train order unit application approach lighted. On track circuits the returns varied from 2.7 to 59.1 per cent. The first cost per installation for the added alternating current apparatus varied from \$10 to \$82 per circuit, the \$82 figure being for power-off relay in connection with flashers. The first cost on track circuits varied from \$10 to \$61 per circuit. Generally speaking, and except as modified by the first cost of the installation as between automatic and non-automatic rectifiers (the automatic rectifiers generally costing more) and also as modified by the cost variation of commercial alternating current, the annual returns vary with the amount of the load which is transferred from the primary battery to the alternating current service, *i.e.*, the heavier the load carried by the alternating current, the greater the economy. When the load carried by the alternating current is light, such as the standby for a motor signal or for a track circuit being shunted by only a few trains per day, there is very little or no economy, even though the life of the primary battery is considerably increased.

Conclusions.

Alternating current primary applications to signal apparatus, either direct through a power-off relay or in floating relation through a rectifier, are an economic means to be considered for reducing operating expenses by increasing the life of primary battery.

Findings.

First cost, economy of installation and return on the expenditure will vary with local conditions.

Action Recommended

Acceptance as information.

METHOD FOR DETERMINING VARIATION OF FREIGHT TRAIN TIME SAVING DUE TO IMPROVED SIGNALING WITH VARYING TRAIN DENSITY

In railway signaling economic studies, the forecasted freight train time savings with centralized traffic control are developed from a study of the actual operation under the prevailing method of directing trains as compared with the estimated operation under centralized traffic control, *based on the same number of trains in both cases.*

In making this comparison to determine the effect of centralized traffic control operation, it is the common practice to record the train movements with the existing operation on a train chart, for each day of the test period chosen for study.

The centralized traffic control operation is then redispached on the train chart and a record obtained for each train showing the changes in road time due to the improvement in directing train movements with the new facilities.

It sometimes happens that traffic conditions change due to various causes, resulting in increased or decreased freight train movements, and it becomes necessary to obtain a revised estimate of the freight train road time savings under the new conditions.

In the past, the solution of this problem required a new study to be made in the manner outlined above, often involving delay due to the redispaching and calculations necessary to secure an answer to the problem.

An analysis of the Theory of Train Performance, A.R.E.A. Proceedings, Vol. 48, p. 125, shows a method for determining the freight train time saving due to improved signaling under varying traffic volume.

It is proposed in this report to apply the A.R.E.A. method to several centralized traffic control studies with varying local conditions and determine the advantages of this procedure as compared to previous practice.

Case 1

Case 1 involves an actual study of before and after centralized traffic control operation on 125 miles of single track. The prior operation, based on January 1944, included time-table, train orders, and automatic block signals. The after operation, based on April 1945, included time-table, centralized traffic control, and automatic block signals. Actual train sheet data were available for both periods, as follows:

Class of train	Before C.T.C. Jan. 1944	After C.T.C. Apr. 1945
Passenger.....	11.1	9.7
Through freight.....	16.8	18.2
Extra freight.....	1.3	1.4
Local freight.....	1.7	1.7
Helper.....	5.1	4.1
Total daily.....	36.0	35.1

Average cars per train in through freights:

Eastward.....	52.5	58.5
Westward.....	54.7	58.0

Average tons per train in through freights:

Eastward.....	1,791	2,052
Westward.....	2,768	2,926
Average.....	2,296	2,501

Road Time Through Freights Daily—Minutes

Item	No. trains	Average road time	Point*	Minimum road time	Point*
Train orders.....	16.8	429	B	245	A
C.T.C.....	18.2	328	D	235	C
Difference.....	1.4	101	H-D	10	A-C

* Note: Refers to points on Performance Chart 1, described later.

These data show that freight traffic was slightly higher and that more cars and tons were hauled with centralized traffic control than with the previous train order operation. Motive power was the same in both periods.

The problem involved in this case was to determine the estimated time saving per through freight train based on an average of 17.2 trains daily. This figure was obtained by checking the train sheets for the years 1944 and 1945, which showed the following train movements:

Year	Total trains	Average per month	Average per day
1944.....	6,270	522.5	17.1
1945.....	6,277	523.1	17.2

Train performance chart.

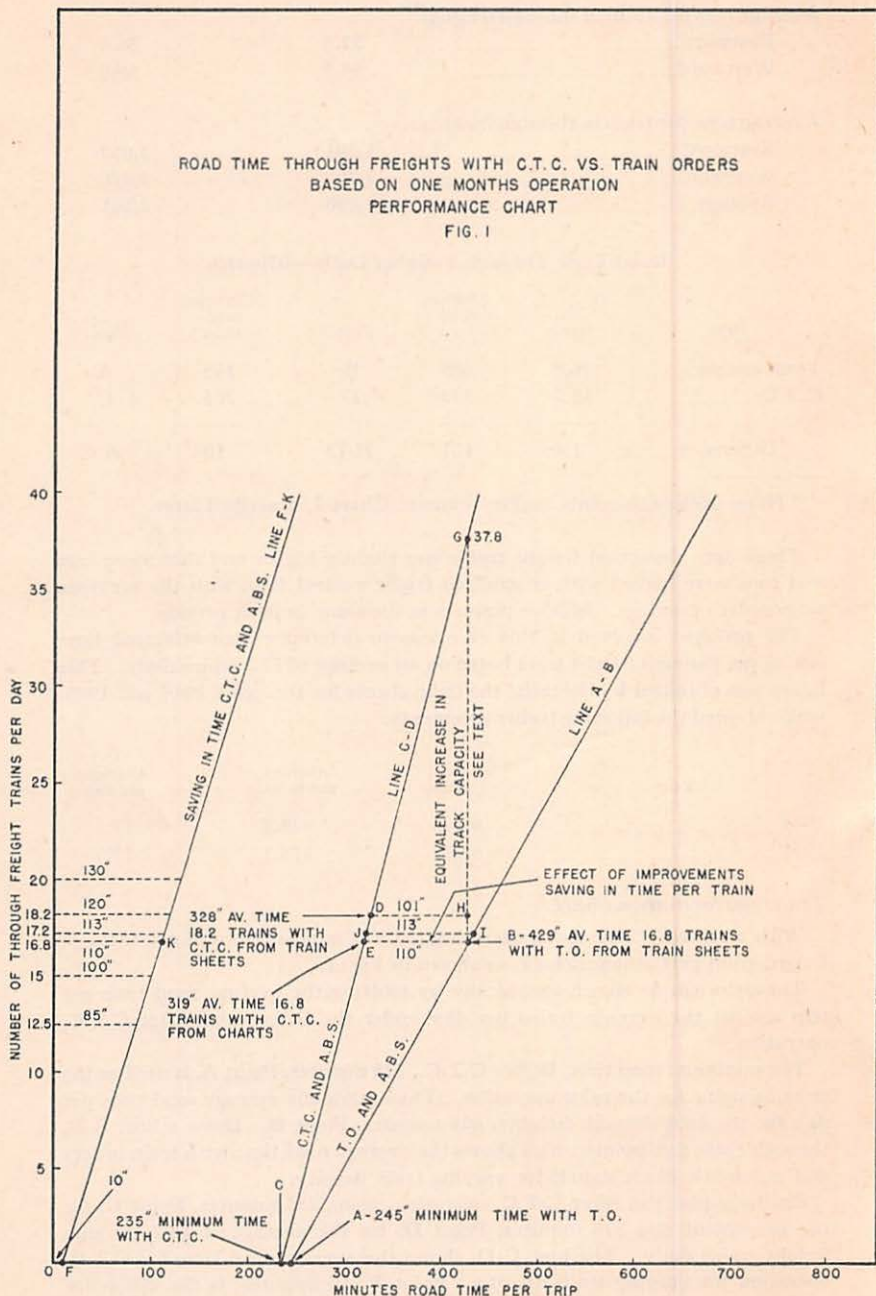
With a record of the above operating data, it is possible to plot a through freight train performance chart, as shown in Fig. 1.

The data can be shown graphically by plotting the average road time per trip against the average trains per day under the Before and After C.T.C. operation.

The minimum road time, Before C.T.C., 245 minutes, Point A, is used as the starting point for the prior operation. Then mark the average road time per day for the 16.8 through freights, 429 minutes, Point B. Draw a line, A-B, through these two points which shows the average road time with train orders and automatic block signals for varying train density.

Similarly plot the After C.T.C. operation, using 235 minutes, Point C, for the base point and 328 minutes, Point D, for the average of 18.2 through freight trains daily. The line, C-D, shows the average road time for C.T.C. operation for varying train density. Point F, 10 minutes, is the difference between Points A and C, 245-235. Point K, 110 minutes, is the difference between Points B and E, 429-319. Then draw line F-K which shows the

ROAD TIME THROUGH FREIGHTS WITH C.T.C. VS. TRAIN ORDERS
BASED ON ONE MONTHS OPERATION
PERFORMANCE CHART
FIG. 1



C.T.C. time saving at varying train density. This line is equal to the difference between lines A-B and C-D and shows the average saving in minutes per train for varying through freight trains per day.

The performance chart shows the following time saving per through freight train for varying traffic as follows:

Average through freights daily	Average minutes saved by C.T.C.
12.5	85
15.0	100
16.8	110
17.2	113
18.2	120
20.0	130

Based on the comparative time saving Before, 16.8 trains, and After C.T.C., 18.2 trains, the C.T.C. time saving per train was 101 minutes, 429-328. The C.T.C. time saving, based on the curves shown in Fig. 1, is 110 minutes for 16.8 trains daily, 113 minutes for 17.2 trains, and 120 minutes for 18.2 trains daily.

The C.T.C. time saving in this case was based on an average of 523 through freight trains operated per month in the years 1944 and 1945 or a daily average for the year of 17.2 trains. Line A-B, for 17.2 trains daily, shows an average of 435 minutes, Point I, for T. O. operation and 322 minutes, Point J, for C.T.C. operation, a time saving of 113 minutes per train. The increased time saving of 12 minutes, 113-101, per train for 523 trains per month for 12 months amounts to 1255.3 hours per year over and above that shown from the train sheet data.

In many cases the base point for train order and C.T.C. operation will be identical. In Case 1 the minimum C.T.C. time was 10 minutes less than with train order operation. This difference in time may indicate superior operating advantages of one system over another or it may be due in part to less favorable weather conditions during one period (January) as compared with the other (April). If less favorable weather conditions are the cause, then the minimum time should be adjusted.

The average time saving per train is represented on the diagram by the horizontal distance between lines A-B and C-D. This saving varies with different train densities as shown by the line F-K.

It can be shown that the vertical distance between lines A-B and C-D represents additional track capacity. (See A.R.E.A. Bulletin 469.)

For example, the vertical line B-G intersects lines A-B and C-D at points B and G which correspond to 16.8 and 37.8 through freight trains respectively. This means an increase in track capacity of 125 per cent would make it possible to operate 125 per cent more trains without increasing the average road time per train based on train order operation. To increase the track capacity 125 per cent requires the addition of 125 per cent more sidings, that is 125 per cent more passing track.

Theoretically centralized traffic control without any change in track capacity is capable of duplicating the performance obtainable from a continuation of train order operation and increased track capacity.

One of the purposes of the diagram is to compare two alternative methods of operation which may produce the same performance. One consists of a direct comparison of actual train performances before and after centralized traffic control was installed in place of train order operation. The other is a direct comparison of train performances based on retaining the train order system but increasing the track capacity an amount (125 per cent) sufficient to duplicate centralized traffic control performance.

From these comparisons it can be concluded that the effect of centralized traffic control in this case is equivalent to an increase of 125 per cent in track capacity (as measured by the number of trains 37.8 against 16.8) in combination with train order operation.

It will be noted that the equivalent increase in track capacity is based on through freight trains and not total trains per day. The number of passenger trains operated per day and local conditions will affect freight train operation particularly where passenger trains are operated in fleets during a few hours per day.

Case 2

Case 2 involves a study on a 117 mile single-track line with time-table, train order, and automatic block signals and a forecast of the estimated through freight train time savings with centralized traffic control operation. The test period was based on three days in August 1946.

The train sheet data were as follows:

Class of train	Average number trains daily
Passenger.....	13.7
Through freight.....	13.0
Extra freight.....	6.3
Helper.....	12.3
Total.....	45.3

The through freights averaged 62.8 cars and 2,474 tons per trip.

Road Time Through Freights Daily—Minutes

Item	No. trains	Average road time	Point*	Minimum road time	Point*
Train orders.....	13	358	B	225	A
C.T.C.....	13	261	D	208	C
Difference.....	0	97	B-D	17	A-C

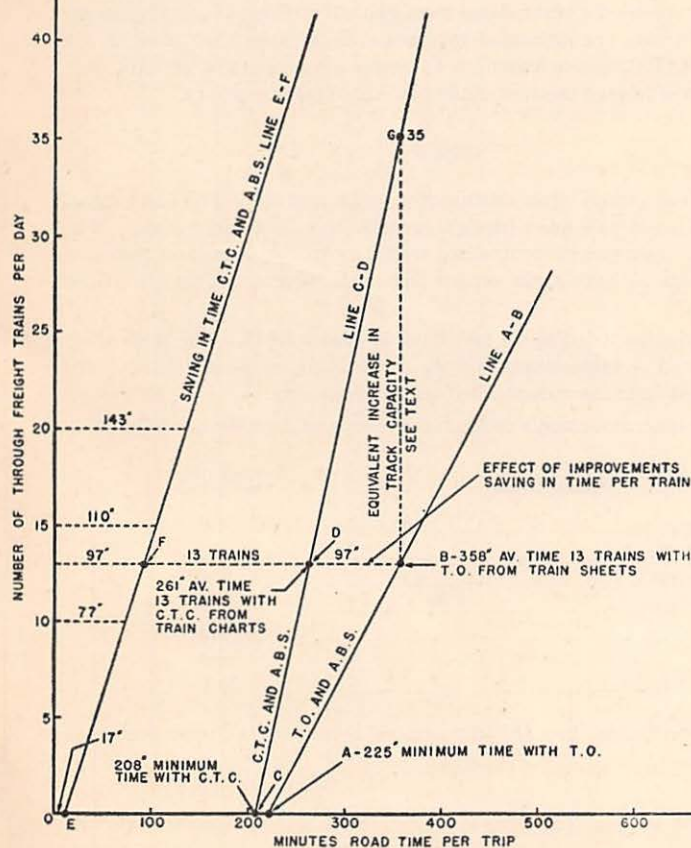
* Note: Refers to points on Performance Chart 2.

The problem in Case 2 is different from Case 1 in that the forecasted improvements are based on the same number of trains before and after centralized traffic control.

Sept. 1948]

ROAD TIME THROUGH FREIGHTS WITH C.T.C. VS. TRAIN ORDERS
 BASED ON THREE DAYS OPERATION
 PERFORMANCE CHART

FIG. 2



Performance chart.

Performance Chart, Fig. 2, has been plotted to show graphically the data in this case. The train order operation, line A-B, is drawn first, then the estimated C.T.C. operation, line C-D. Point E, 17 minutes, is the difference between Points A and C, 225-208. Point F, 97 minutes, is the difference between Points B and D, 358-261. Then draw line E-F which shows the C.T.C. time saving at varying train density.

This performance chart shows the estimated time saving for varying traffic as follows:

Average through freights daily	Average minutes saved by C.T.C.
10	77
13	97
15	110
20	143

Line C-D intersects the vertical line from Point B at Point G at 35 trains per day. The 35 trains are estimated to require an average road time of 358 minutes with C.T.C. as compared to 13 trains averaging 358 minutes with train orders, an estimated increase of 169 per cent in track capacity.

Case 3

Case 3 involves a study of an existing train order and automatic block signal installation on a 100 mile line with lighter traffic than in Cases 1 and 2. The forecasted time savings with centralized traffic control are based on the same train movements as with train orders and with increased through freight trains.

The test period included seven test days in March 1947. The train sheet data were plotted on train charts and the time saving with centralized traffic control compiled from the redispached train movements.

The average train movements daily on the seven test days were as follows:

Class of train	Average number trains daily
Passenger.....	4.0
Through freight.....	6.1
Extra freight.....	5.4
Local freight.....	1.7
Other.....	2.9
Total.....	20.1

The basic data for the through freight trains, average of the seven test days, were as follows:

March 1947 Traffic

Average cars per train.....	61.8
Average tons per train.....	2,784
Average road time per through freights, T.O.....	223.8 minutes
Minimum road time, T.O. and C.T.C.....	185.0 minutes
C.T.C. average road time.....	203.4 minutes

With these basic data, Fig. 3 was drawn showing lines A-B, A-C, and O-F, as in the two previous Cases.

Performance Chart, Fig. 3, line A-B, shows the estimated time with 5 additional through freight trains, a total of 11.1 trains daily, with train orders at 255 minutes. Line A-C shows with C.T.C., for 11.1 trains, an average time of 218 minutes or an estimated C.T.C. time saving of 37 minutes, as shown by line O-F.

The performance chart shows the following time saving per through freight for varying traffic:

Average through freights daily	Average minutes saved by C.T.C.
5.0	17.0
6.1	20.4
8.0	26.0
10.0	32.0
11.1	37.0

The small time saving in Case 3 as compared to the previous cases is apparent and is due to the lighter traffic per day.

Comparison of train charts with performance charts.

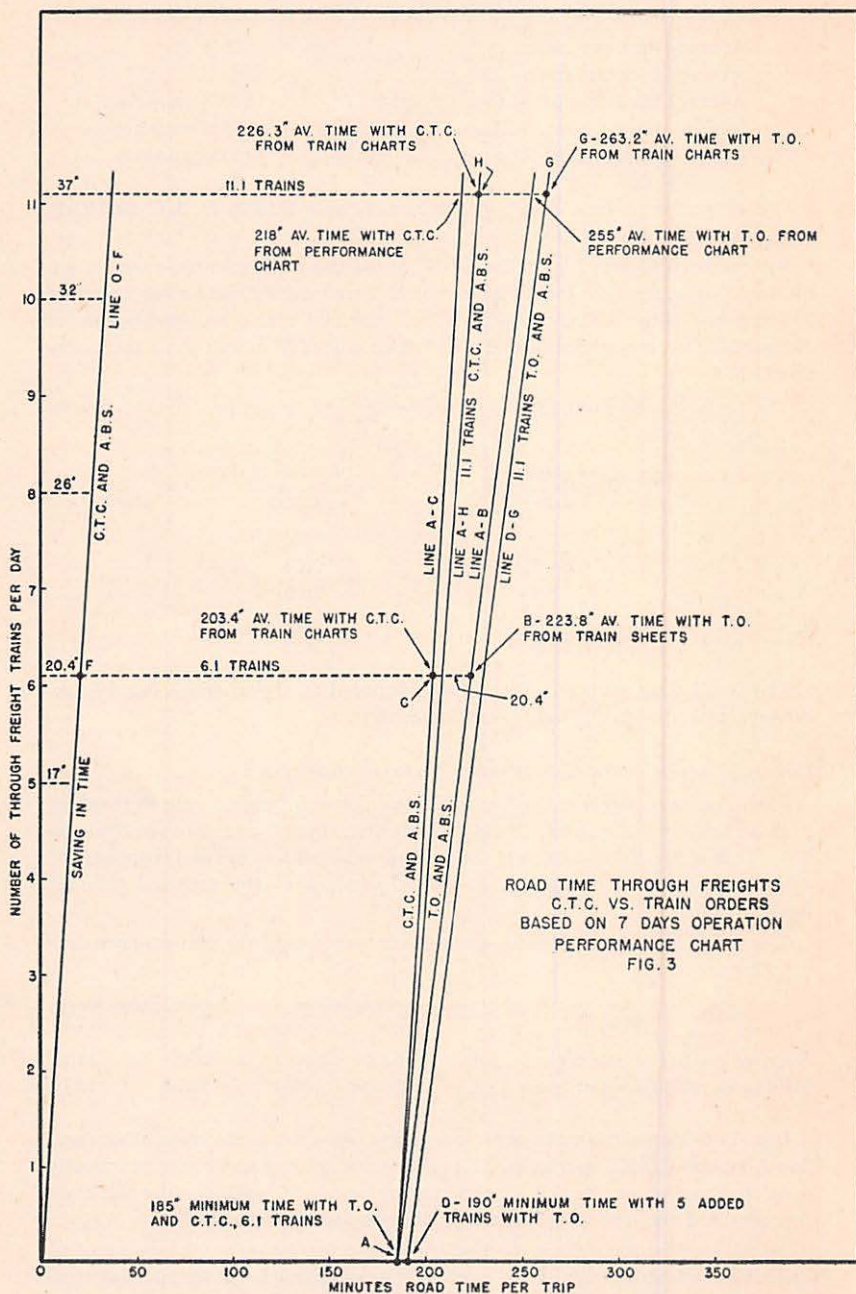
Following past practice, the five additional through freight trains were added to those already on the train charts without disturbing the previous redispatching. That is, the five trains were dispatched with train orders and redispatched with centralized traffic control as second sections of the previous through freight trains.

The train chart data for the five trains compared with the performance data as follows:

Item	Train charts		Performance chart	
	T.O.	C.T.C.	T.O.	C.T.C.
Average road time per train.....	263.2	226.3	255	218
Minimum road time per train.....	190.0	185.0	185.0	185.0

Line D-G shows the train order operation taken from the train charts and line A-H, the C.T.C. operation. The difference in the two lines is practically equal to line O-F as the C.T.C. time saving equals 36.9 minutes by the train chart method and 37 minutes by the performance data method.

As the performance chart method requires a few hours work compared to several days for the train chart method, the advantages of determining time savings by this method are readily apparent.



Conclusion.

The A.R.E.A. performance chart method of analysis may be used to make the following additional comparisons:

- Train hours
- Train tonnage
- Train miles
- Gross ton miles
- Crew time
- Initial terminal time
- Final terminal time

The time saving due to improved operation may be divided by traffic direction, *i.e.*, Eastward and Westward or North and South, if desired. Similar charts can be made for passenger and other trains. Each class of train should be charted separately although symbol freights and extra freights can be combined provided they run the same distance.

The A.R.E.A. performance charts show the road time in hours rather than minutes but either method can be used. It is desirable to use a larger scale than the samples shown for more accurate reading. The scale for time per trip, etc., will depend upon local conditions. It is assumed that motive power is the same before and after the improvements.

The performance chart method provides a means of comparison before and after an improvement where the trains and tonnage or both are different in the periods compared.

The use of performance charts provides an improved method of studying train records and their use in signaling studies is worthy of adoption.

Action Recommended

Acceptance as information.

ECONOMICS OF SIDING SIGNALING

In 1945* Committee I presented a comprehensive report on the economics of signaling turnouts, which included a graphic chart showing time involved in slowdowns and stop of a 5,450 ton gross weight train from a maximum speed of 55 miles an hour. That report concluded that where traffic is predominantly high speed and heavy tonnage, some of the conditions to be met are as follows:

1. No. 15 to No. 20 turnouts for medium speed through turnout and siding.
2. Track circuited sidings where trains or engines are prohibited by rules from re-entering siding without permission after once having cleared.
3. Medium speed indications governing moves into the siding when unoccupied, with a restricting indication for following trains only.
4. Approach medium indication on the approach signal to a siding home signal.
5. Siding of sufficient length to permit medium speed of entire train through entering turnout.
6. Siding of sufficient length to permit medium speed through the siding and turnouts.

An East-West railroad has recently installed centralized traffic control on 47.7 miles of single track and provided signaling for four sidings that have capacities of 137, 144, 234 and 408 cars, in accordance with track and signal plan shown in Fig. 1.

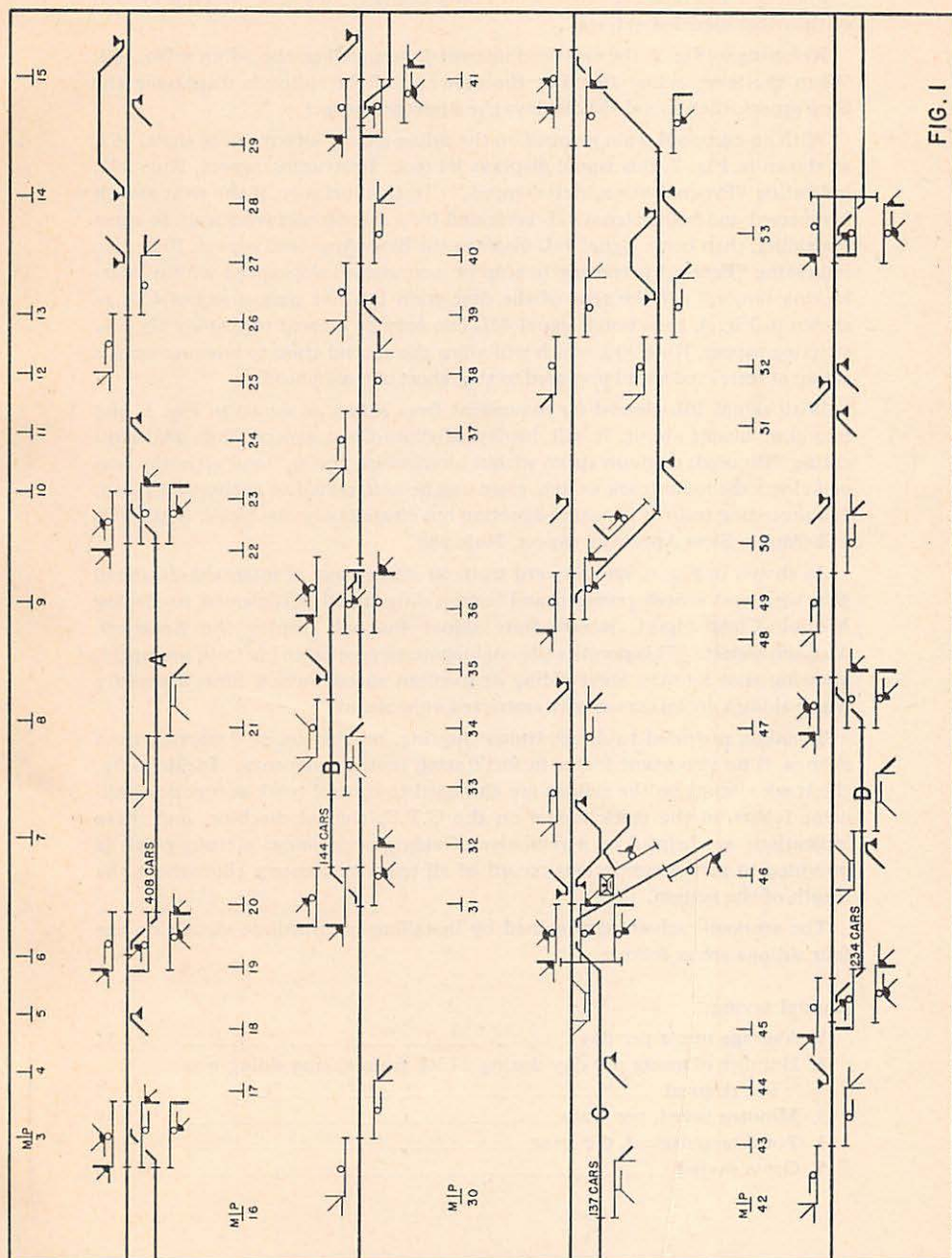
Curves in the main track are fairly numerous but none are of such curvature as to limit freight train speeds below 45 m.p.h., which is the maximum authorized freight train speed for the territory. The maximum authorized passenger train speed is 50 m.p.h., except on six curves which are restricted to 45 m.p.h.

By providing a helper locomotive from milepost 1 eastward on ascending grade, to milepost 8, road locomotives handle about 7,000 gross tons, ranging from 90 to 100 cars. In addition to coal trains there are five preference merchandise freight trains each way daily, each of which averages from 4,500 to 5,000 gross tons. A local freight is operated each way daily except Sunday, and a local passenger train makes a round trip daily. The traffic varies on different days of the week and in different months of the year, so that the number of trains ranges from 25 to 30 daily.

The turnouts at the ends of the signaled sidings are No. 15, good for train speeds of 30 miles per hour and the home signals for the sidings are arranged to display Medium-Clear aspect, Standard Code Rule 283, with signal in the rear arranged to display Approach Medium aspect, Rule 282.

The intermediate signals on the sidings provide approach indication for the leave siding home signals as well as spacing trains on the siding. These siding signals are of the pedestal type with two operative units and all signals are at the immediate right of the tracks governed. They are mounted on short masts high enough to bring the lowest lamp 3 feet 10 inches above the level of the base of rail in order that they can be located between tracks having 15 foot centers without fouling clearance limit. Twenty foot centers were provided between the main track and siding for the station-leaving home signals as standard ground poles are used at these locations.

* A.A.R. Signal Section 1944 Proceedings, Vol. XLII, p. 25-A.



Figures 2 to 6 illustrate signals on siding D shown in Fig. 1, which is typical of the other signaled sidings.

Referring to Fig. 2, the eastward intermediate signal on the siding is No. 462. When the leave siding signal at the east end of the siding is displaying the Stop aspect, then signal 462 displays the Approach aspect.

With an eastward train stopped on the siding east of intermediate signal 462, as shown in Fig. 3, this signal displays its most Restricting aspect, Rule 290, indicating "Proceed at restricted speed." In this instance, if the west switch is reversed and home signal 42L is cleared for a second eastward train to enter the siding, then home signal 42L displays the Slow-Approach aspect, Rule 288, indicating "Proceed preparing to stop at next signal; slow speed within interlocking limits." If the rear of the first train has not passed signal 462, as shown in Fig. 4, then home signal 42L can only be cleared to display the Restricting aspect, Rule 290, which will allow the second train to advance on the siding at restricted speed prepared to stop short of train ahead.

With signal 26L cleared for movement from siding as shown in Fig. 5, and two clear blocks ahead, it will display Medium-Clear aspect, Rule 283, indicating "Proceed; medium speed within interlocking limits," and after the rear end clears the main track switch, train can be accelerated to authorized speed. If a preceding train of the same direction has cleared only one block, signal 26L will display Slow-Approach aspect, Rule 288.

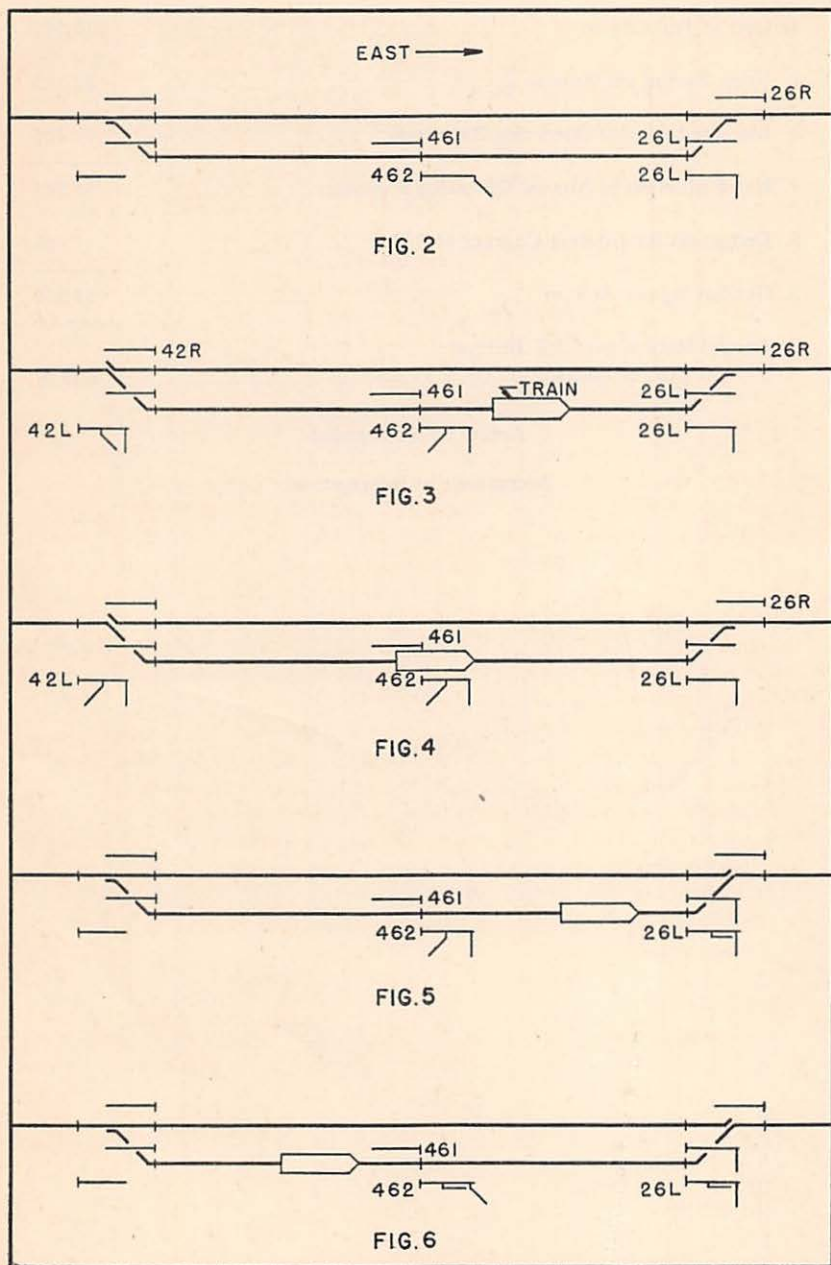
As shown in Fig. 6, an eastward train on siding west of intermediate signal 462, with east switch reversed and leave siding signal 26L cleared to display Medium-Clear aspect, intermediate signal 462 will display the Approach Medium aspect. This permits the engineman to accelerate his train promptly, knowing that he may leave siding at medium speed, saving time, especially where sidings are on curves with restricted view ahead.

Signaling provided to direct trains entering, moving on or departing from sidings, is an important factor in facilitating their movements. Incidentally, the track circuits on the sidings are also used to control track-occupancy indicator lamps on the track model on the C.T.C. control machine, and these indications are helpful as a reminder of siding occupancy; a train graph is provided to give a continuous record of all train movements throughout the length of the system.

The economic advantages gained by installing intermediate signals on the four sidings are as follows:

Annual saving:

1. Average meets per day.....	31
2. Number of meets per day during which train taking siding was not stopped.....	2
3. Minutes saved, per train.....	7
4. Total hours saved, per year.....	85
5. Gross saving.....	\$2,185



Economic Statement

1. Cost of Installation.....	\$15,515
2. Gross Saving per Annum.....	\$2,185
3. Increased Annual Operating Expenses.....	400
4. Net Reduction in Annual Operating Expenses.....	\$1,785
5. Deduction for Interest Charges @ 3%.....	465
6. Net Saving per Annum.....	\$1,320
7. Annual Return over 3% Interest: On Cost of Installation ($6 \div 1$).....	8.51%

Action Recommended

Acceptance as information.

FORMULAE FOR ESTIMATING TRAIN MILES SAVED DUE TO INCREASED TONNAGE WITH CENTRALIZED TRAFFIC CONTROL

Centralized traffic control often permits an increase in tonnage per train not only on the C.T.C. territory, but on adjoining territories. This increased tonnage per train is made possible for the following reasons:

(a) In centralized traffic control territory:

1. Power operation of siding switches and direct control of meeting and passing points eliminates conditions which limit tonnage by reducing possibility of stalling trains where switches were formerly hand-operated.
2. The reduction in road time from terminal to terminal, by elimination of delays incident to time-table and train orders, may be sufficiently great to warrant operation of heavier trains within the scheduled time. The heavier and longer train, while not capable of attaining the maximum actual running speeds of the lighter train, can still make better terminal to terminal time with C.T.C. than with the former method of directing train movements.
3. Starting terminal time is usually reduced with C.T.C.

(b) In territory beyond the centralized traffic control installation:

1. Earlier arrival at the leaving end of C.T.C. territory makes it possible to adjust tonnage advantageously on the adjoining subdivision. This condition exists where tonnage allowed for time freight trains is adjusted upward or downward, depending upon whether the train is on schedule, ahead of schedule, or behind schedule.

Two methods are available for computing the train miles saved: one, shown in Case A, is used where the information available is for gross ton miles (G.T.M.), and Case B, where train miles is available.

Where installation of centralized traffic control affects the number of train miles on adjoining territories, a separate study should be made.

Predominating tonnage generally governs the number of trains required. To balance power and crews, the number of trains in light tonnage direction is generally equal to that for predominating tonnage direction; therefore, a multiplier of 2 is used in determining train miles saved.

Case A

Formula for train miles saved:

$$\text{Train miles saved per year} = \left(\frac{A}{B} - C \right) \times 2 \times \frac{12}{N}$$

Where A = G.T.M. after C.T.C. in direction of predominating traffic.

B = Average tonnage per train before C.T.C. in direction of predominating traffic.

C = Actual train miles after C.T.C. in direction of predominating traffic.

2 = Multiplier to include trains in opposite direction.

12 = Months per year.

N = Number of months under consideration.

Example:

A centralized traffic control installation* of 55.74 miles of single track and 4.95 miles of two main tracks on a railroad in the Southwestern Region. C.T.C. was installed in 1943. The C.T.C. section is only a portion of an operating division.

Data available:

9 months period (N)	Northward (Predominating direction)	
	Before C.T.C.	After C.T.C.
Total gross ton miles (G.T.M.).....	2,073,860,000	2,052,805,000 (A)
Total freight train miles.....	624,234	552,726 (C)
Average tons per train.....	3,322 (B)	3,714
Increase in average tons per train: (3,714-3,322).....		392
No change in tractive effort of locomotives.		

Substituting the values in the formula:

$$\left(\frac{2,052,805,000}{3,322} - 552,726 \right) \times 2 \times \frac{12}{9} = 173,904 \text{ train miles saved per year.}$$

*Case B**Formula for train miles saved:*

$$\text{Equivalent train miles saved per year} = \left(\frac{D}{B} - E \right) \times 2 \times F \times \frac{12}{N}$$

Where D = Total tons hauled after C.T.C. in direction of predominating traffic.

B = Average tonnage per train before C.T.C. in direction of predominating traffic.

E = Total through freight trains after C.T.C. in direction of predominating traffic.

2 = Multiplier to include trains in opposite direction.

F = Length of C.T.C. in miles.

12 = Months per year.

N = Number of months under consideration.

Example:

A centralized traffic control installation of 125.3 (F) miles of single track on a railroad in the Central Western Region. C.T.C. installed in 1945. C.T.C. covers entire subdivision.

* A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, p. 15.

Data available:

One month period (N)	Eastward		Westward	
	Before C.T.C.	After C.T.C.	Before C.T.C.	After C.T.C.
Total through freight trains.....	251	268	269	280 (E)
Total cars hauled.....	13,178	15,863	14,717	16,253
Total tons hauled.....	449,551	549,942	744,598	819,205 (D)
Average tons per train..	1,791	2,052	2,768 (B)	2,926
No change in tractive effort of locomotives.				

Substituting the values in the formula:

$$\left(\frac{819,205}{2,768} - 280 \right) \times 2 \times 125.3 \times \frac{12}{1} = 48,115 \text{ train miles saved per year.}$$

The two formulae are interchangeable. One can be converted to the other by the use of the following equivalents:

$$A = F D \text{ and } C = F E$$

Action Recommended

Acceptance as information.

REDUCTION IN SIDINGS ON SINGLE-TRACK LINES WITH
CENTRALIZED TRAFFIC CONTROL OPERATION

The Committee submitted a report on this subject at the 1945 Annual Meeting* covering 16 railroads. The following report on 24 railroads, which includes the 16 railroads previously covered, brings the subject up-to-date:

Railroad	Road miles	Average number of trains daily	Number of sidings T.O.	Number of sidings C.T.C.	Per cent reduction	Average C.T.C. spacing miles
A	732.70	37.9	132	125	5.3	5.9
B	103.90	41.3	28	25	10.7	4.2
C	373.80	32.3	65	55	15.4	6.8
D	600.83	22.0	97	81	16.5	7.4
E	111.00	16.0	17	12	29.4	9.3
F	518.22	37.5	86	55	36.0	9.4
G	199.10	38.0	41	33	19.5	6.0
H	136.99	23.3	16	15	6.3	9.1
I	11.70	25.0	3	2	33.3	5.9
J	602.00	34.9	146	77	47.3	7.8
K	118.82	40.0	40	25	37.5	4.8
L	332.98	40.0	85	70	17.7	4.8
M	344.80	35.0	73	59	19.2	5.8
N	205.11	22.0	43	38	11.6	5.4
O	51.80	60.0	10	10	—	5.2
P	91.80	18.5	13	10	23.1	9.2
Q	262.30	34.4	65	46	29.2	5.7
R	159.60	26.0	35	21	40.0	7.6
S	482.00	46.7	121	103	14.9	4.7
T	357.30	45.9	116	110	5.2	3.2
U	173.90	36.0	32	31	3.1	5.6
V	747.30	39.2	169	137	18.9	5.6
W	116.00	14.0	27	27	—	4.3
X	57.80	25.0	11	8	27.3	7.3
Total	6,891.75		1,471	1,175	20.1	5.9

Action Recommended

Acceptance as information.

* A.A.R. Signal Section 1944 Proceedings, Vol. XLII, p. 30-A.

ECONOMICS OF AUTOMATIC OSING SYSTEMS

There are several designs of automatic OSing systems in use by railroads, including:

Railroad	Number of installations	OSing indication	Year installed
A.T. & S.F.	*6 single track *6 two main tracks	} audible and visual	1936 1937-1945
	* Three for each direction		
C.M.St.P. & P.	8 single track 3 two main tracks	} audible	between 1938 and 1946
C.R.I. & P.	1 single track 1 two main track		1945 and 1946
Missouri Pacific	3 single track	audible	1936 to 1938
New York Central	28 controlled manual block signals	visual	1928
Norfolk & Western	1 single track 7 multiple track	} audible	between 1912 and 1945

In addition to the above 10 installations, there are over 160 installations of the automatic train graph as generally used with centralized traffic control and, in some cases, with remote control. A brief description of some of the installations is as follows:

Atchison, Topeka & Santa Fe Ry.

The transmitting and receiving of indications is accomplished by train occupancy of track circuit which starts the train announcer mechanism, sends buzz signal in Morse Code to dispatcher for seven seconds, and then disconnects. The existing dispatcher's telephone circuit is employed for this purpose along with a C-5 carrier and simplex circuits.

Chicago, Milwaukee, St. Paul & Pacific R.R.

Track circuits provided to detect train occupancy. When track is occupied, a howler is actuated on a rotary stepping switch actuated to give code call for nearest station. Ordinarily a time element cut-out is provided to discontinue the audible indication after 30 seconds. The indications are transmitted over dispatcher's telephone circuits.

Chicago, Rock Island & Pacific Ry.

Audio signals having frequencies identified with fixed points along the rail lines are transmitted over existing wayside wires to the dispatcher's office. They pass through selective filters, amplifiers, trigger tubes and relays to signal lamps and pens which indicate and record time of arrival and departure. A complete write-up of this system appears on page 330, *Railway Signaling*, May 1946.

Missouri Pacific R.R.

Transmitter is connected to line through train occupancy of track circuit,

and indications are transmitted over dispatcher's telephone circuits for OSing purposes. One installation is to allow engineman to advise centralized traffic control operator by whistle code signal that water will be taken at the next tank.

New York Central R.R.

This railroad employs automatic OSing in connection with remotely controlled manual block signals, the details of which are discussed in the April 1929 issue of *Railway Signaling*. Track circuits and line wires employed for control of signals and lock circuits are also used to bring in the OSing indication.

Norfolk & Western Ry.

Energy for the OS signals is impressed on the dispatcher's telephone circuits and amplified for an audible indication. Two general types of OSing are used: one type consists of the output of a vacuum tube oscillator being coded on telephone circuit by means of motor driven keying device, actuated by the track circuit and arranged to send a continuous telegraphic symbol for a 25 second interval. The second type consists of a telephone transmitter connected to the telephone circuit and track circuit energized.

Automatic Train Graph

This device has been developed for use in connection with centralized traffic control and remote control installations to provide a permanent record of passing trains. The graph consists of a clock-actuated mechanism which moves the graph sheet under magnetically operated pens to form a record of occupancy of the track circuits. Directional information is provided.

The indications for operation of the train graph pens originate with track occupancy and are transmitted over the code line through a series of relays. The operation of the train graph can also be arranged to carry the codes through the dispatcher's present circuit.

Advantages of OSing systems.

Provides the dispatcher with additional information on the movement of trains and enables better planning of train operations.

For some systems, particularly the automatic train graph, it is possible to use the information quite extensively, including:

(a) Train delays can be readily ascertained and the cause determined for benefit of future operations.

(b) Provides a means of checking whether signals are properly cleared in advance of train movements.

(c) Graphs are checked to determine if the best use is made of available facilities in planning train movements.

(d) Provides a check to determine whether crews are complying with restrictive signals.

(e) The graphs are also checked by railroad officers to determine that train movements are properly handled, and for the purpose of arranging train schedules.

Economic advantages.

Specific data have not been made available by the railroads to determine the economic benefits of automatic OSing installations. However, due to the use of existing track circuits and line wires, the total cost is relatively low compared to the economic benefits. It is reasonable to assume that the return on the investment will exceed 50 per cent annually.

Conclusion.

Automatic OSing systems are recommended as an economic means to be considered for reducing operating expenses and expediting traffic.

Action Recommended

Acceptance as information.

TRAIN HOUR VALUE*

At the 1946 Annual Meeting the Committee presented a complete report on Train Hour Value. The report indicated that two sources of information were available from which detailed costs could be obtained for use in determining Train Hour Value. One of these sources, an annual report issued by the I.C.C. Bureau of Statistics entitled "Comparative Statement of Railway Operating Statistics, Individual Steam Railways in the United States Having Annual Operating Revenues over \$5,000,000," is no longer issued. In the 1946 report there is some inconsistency in the use of the words "Value" and "Cost." Therefore, the report as now presented is a revision of the 1946 report which includes these corrections and other revisions where further clarification appeared desirable, and also brings cost data up-to-date.

This revised report outlines a recommended method for determining the value of a train hour using as the basis the average cost items included in Annual Report Form A submitted by Class I railroads to the I.C.C.

The average costs so developed may be adjusted to fit local conditions on any railroad or subdivision under study, giving consideration to the factors which make up the cost of the train hour, taking credit for such of those factors shown in Table I as will be saved in evaluating the saved train hour. To such costs must be added the estimated value of intangibles, some of which are mentioned in this report, in order to obtain total Train Hour Value. Thus, Train Hour Value is comprised of train hour costs as so determined plus the value placed upon intangibles.

When knowing the Train Hour Value (THV) and the train hours saved, the total saving to be effected is the product of the two.

Table I shows account numbers according to the I.C.C. classification and page references to locate the items of cost in Annual Report Form A and also formula for certain calculations.

TABLE I

Items	I.C.C. Account Classification	Form A Report Reference (1946)
1—Overtime wages.....		{ Page 524 Schedule 561-B
Wages, train and enginemen.....	392-393 & 401	} Page 309 Schedule 320
2—Train fuel.....	394	
3—Water for train locomotives.....	397	
4—Lubricants for train locomotives.....	398	
5—Other supplies for train locomotives.....	399	
6—Enginehouse expenses—train.....	400	
7—Train supplies and expenses.....	402	

* A.A.R. Signal Section 1940 Proceedings, Vol. XXXVIII, pp. 20 and 344.

A.A.R. Signal Section 1941 Proceedings, Vol. XXXIX, pp. 15 and 198.

A.A.R. Signal Section 1942 Proceedings, Vol. XL, pp. 25-A and 275-A.

A.A.R. Signal Section 1943 Proceedings, Vol. XLI, pp. 21 and 282.

A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, pp. 40 and 290.

A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, pp. 48-A and 334-A.

TABLE I—Continued.

Items	I. C. C. Account Classification	Form A Report Reference (1946)
8—Locomotive repairs.....	308 & 311	{ Page 307 Schedule 320
9—Locomotive depreciation.....	331	{ Page 313-B Schedule 320-F
10—Interest on locomotive invest- ment.....		
11—Payroll taxes.....		

In addition, the following information must be obtained:

A—Road freight train hours.....	Item 64 Col. B	{ Page 508 Schedule 531
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Formula

$$B\text{—Train Hour Cost} = \frac{\text{Sum of Items 1 to 11}}{\text{Item A}}$$

The following explanations refer to the items enumerated in Table I:

Item 1—Wages.

Wages are only to be considered when on overtime basis. When overtime wages are included, payroll taxes, Item 11, must also be applied and included with other taxes in Item 11.

Overtime wages are shown in Annual Report Form A, Schedule 561-B on page 524. Column (g) Overtime Compensation and Column (h) Total Compensation are listed for the various classifications as follows:

Div. No.

- 113 Road freight conductors (through freight).
- 114 Road freight conductors (local and way freight).
- 117 Road freight brakemen and flagmen (through freight).
- 118 Road freight brakemen and flagmen (local and way freight).
- 122 Road freight enginemen and motormen (through freight).
- 123 Road freight enginemen and motormen (local and way freight).
- 126 Road freight firemen and helpers (through freight).
- 127 Road freight firemen and helpers (local and way freight).

Column (g) Schedule 561-B is the only place in Annual Report Form A, where overtime is shown separately and because of the minimum day and mileage basis of computing wages, the Bureau of Railway Economics, A.A.R., recommends that in place of using the figures direct as shown in Column (g) that a fairer basis would be to determine the ratio of Column (g) to Total figures shown in Column (h) and applying this percentage to the amount of wages for Accounts 392, 393 and 401, shown on page 309 of Annual Report Form A, and using the result as amount of overtime wages.

This procedure of using a percentage of these Accounts will automatically include other items such as work charged to operating expenses, which would be excluded by using figures direct from Column (g). Attention is called to the

fact that Accounts 392, 393 and 401 include both overtime and straight time wages, without separation, in one total amount. Where the overtime information required is available, the foregoing process need not be followed.

Item 2—Fuel.

Account 394 does not include cost of on line fuel transportation. An allowance should be made over the listed cost of train fuel to cover cost of its on line transportation. For the year 1946 this cost averaged 5.31 mills per net ton mile for Class I railroads in the United States. Each railroad can provide its own cost per ton mile. Also, each railroad has a record of its average length of haul.

Item 9—Locomotive depreciation.

This item should include charges for depreciation for all road freight locomotives. Reports to the I.C.C. covering these charges are classified as Account 331. Annual Report Form A does not provide for separating them between yard and freight locomotives. An item in the same report, Schedule 320, page 307, however, covering charges for "Locomotive Repairs," Accounts 308 and 311, does show a separation between such charges for yard and freight locomotives. The approximate road freight locomotive depreciation can therefore be determined by taking the ratio of "Road Freight Locomotive Repairs" to "Total Freight Locomotive Repairs" and applying it to the "Total Depreciation Charges for Freight Locomotives." While this is an appreciable element of Train Hour Cost, the result thus obtained is considered sufficiently accurate, and to obtain it in any other manner by breaking down the present accounts would not be justified.

Locomotive retirements.

This item was formerly carried as Account 310 but is eliminated from further consideration because the railroads have discontinued accounting under this classification in accordance with latest prescribed I.C.C. rules. Hereafter charges to I.C.C. Account 331, covering Item 9—Locomotive depreciation, will be sufficient to include what was formerly charged under "Locomotive retirements."

Item 10—Interest on locomotive investment.

Investigation of this item indicates that the present practice is to charge only interest on "Locomotive investment" as is currently paid on the Equipment Trust Certificates. Railroad accounting practices do not provide for separation of these charges. The total amount involved for all classes of equipment in each Equipment Trust Certificate is reported in Annual Report Form A. Each railroad can, of course, separate the amount applicable to road freight locomotives, and the total annual charges for road freight locomotives can thereby be determined. However, since the total annual charge for one representative railroad for 1942 was only \$0.11 this is classified as a minor item, and its value will be omitted from further consideration in this report.

Item 11—Payroll taxes.

This item should include payroll taxes at the prevailing rate ($6\frac{1}{2}$ per cent in 1946) of all overtime wages for train and enginemen, Item 1, and labor ap-

plicable to Item 6—Enginehouse expenses, and Item 8—Locomotive repairs. The interest rate for payroll taxes is regulated by Federal law and prescribed to change from time to time, in which event it will, of course, be necessary to change the rate accordingly. The rate effective January 1, 1947 is $8\frac{3}{4}$ per cent. The total charges for Item 6 are covered by Account 400, while the total charges for Item 8 are covered by Account 308. These charges are reported in the railroads' Annual Reports Form A without showing separately the cost of labor. It is therefore necessary to separate the labor from the total charges, and while this is more readily obtainable from the railroads' detailed accounts, it can be determined on the basis of assuming the same percentage of labor to total charges shown in Annual Report Form A as has generally prevailed in the past, which is:

- 85 per cent for enginehouse expenses, and
- 70 per cent for road freight locomotive repairs.

Additional items.

Costs of double-header, pusher or helper, Diesel and electric propulsion operation are in Items 1 to 11 inclusive and are not separately shown in Annual Report Form A. Therefore, when it is desired to set up these charges separately or to emphasize what additional expense they may entail, thereby increasing the cost of train hour, it will be necessary that the costs be obtained from the reports of the railroad's particular division where these services are used.

Intangible items.

Consideration should be given to the following items, which while generally considered intangible should be evaluated on the basis of local operating conditions:

1. Availability of equipment.
2. Improved service to shippers.
3. Competitive position with other carriers.
4. Value of on-time deliveries, thereby saving penalty of missed market deliveries.

After it has been determined which of the above items are to be considered and the amounts for each have been obtained, the following procedure is necessary to arrive at the Train Hour Value:

1. Total the amounts of Item 1 to and including Item 11, Table I.
2. The sum of these items to be divided by the amount representing Item A.
This result will equal the Train Hour Cost, Item B.
3. To Item B should be added the hourly value of the intangibles to obtain the total Train Hour Value.

The amount of Items 1 to 11, inclusive, is obtainable from Annual Report Form A, as has been explained. For convenience, train hour costs per road freight train hour, Items 2 to 11, have been compiled for the year 1946 by the Bureau of Railway Economics, A.A.R., and are shown in Table II. The table shows system costs for 82 Class I railroads, together with composite average costs for those railroads and average costs by regions. Inasmuch as the amount of overtime is usually available for the territory involved and becomes a direct payroll saving, it has not been included in Table II. If the direct information is not available, Item 1, Table I, should be determined and added to Items 2

to 11 to produce complete train hour cost. Payroll taxes for other than train crew wages are included in Item 11, Column 4.

The amounts comprising the cost of train hour for the composite average of the 82 railroads are as follows:

Items 2 to 8, inclusive, Col. 2.....	\$24.41
Item 9, Col. 3.....	1.04
Item 11, Col. 4.....	0.50
Total Train Hour Cost, Col. 5.....	\$25.95

For those who desire to use cost figures as prepared on system basis to represent the value of the train hour saved, Table II will supply the information with Annual Report Form A as the source but without the necessity of detailed calculations.

Action Recommended

Acceptance as information.

Table II

SPECIFIED ELEMENTS OF TRAIN HOUR COST PER ROAD FREIGHT TRAIN HOUR - YEAR 1946

(Excluding road freight train crews' wages)

Railroad	Elements of train hour cost (per road freight train hour)			
	Fuel, supplies, enginehouse expense and locomotive repairs	Road freight loco- motive depre- ciation	Payroll taxes on labor applicable to road freight loco. repairs & enginehouse expense <u>a</u>	Total train hour cost (excluding train crew wages)
1	2	3	4	5=2+3+4
Item number in report	Items 2 to 8	Item 9	Item 11	Items 2 to 11
NEW ENGLAND REGION:				
1 Bangor & Aroostook	\$27.61	\$1.23	\$0.58	\$29.42
2 Boston & Maine	21.59	0.96	0.48	23.03
3 Central Vermont	24.39	1.05	0.42	25.86
4 Maine Central	21.87	0.67	0.41	22.95
5 New York, New Haven & Hartford	27.16	1.25	0.58	28.99
6 Rutland	17.39	0.64	0.31	18.34
GREAT LAKES REGION:				
7 Grand Trunk Western	26.96	1.32	0.37	28.65
8 Erie (Incl.Chgo.& Erie)	27.88	1.47	0.59	29.94
9 New York, Chicago & St. Louis	27.69	0.94	0.53	29.16
10 Delaware & Hudson	42.13	1.71	0.93	44.77
11 Delaware, Lackawanna & Western	25.77	1.83	0.43	28.03
12 Lehigh & New England	17.60	0.85	0.31	18.76
13 Lehigh Valley	34.14	1.87	0.58	36.59
14 Monongahela	12.01	0.79	0.25	13.05
15 New York, Ontario & Western	15.93	1.47	0.34	17.74
16 New York Central (Incl.B.& A.)	24.50	1.28	0.50	26.28
17 Pittsburgh & Lake Erie	34.61	1.63	0.61	36.85
18 Pere Marquette	24.06	1.26	0.40	25.72
19 Ann Arbor	20.33	0.74	0.39	21.46
20 Wabash	22.93	0.94	0.45	24.32
CENTRAL EASTERN REGION:				
21 Baltimore & Ohio	23.73	0.82	0.55	25.10
22 Bessemer & Lake Erie	80.76	5.26	2.37	88.39
23 Chicago & Eastern Illinois	21.66	0.95	0.49	23.10
24 Chicago, Indianapolis & Louisville	22.50	1.06	0.54	24.10
25 Detroit, Toledo & Ironton	17.41	1.26	0.25	18.92
26 Elgin, Joliet & Eastern	12.55	0.48	0.26	13.29
27 Illinois Terminal	8.45	0.61	0.14	9.20
28 Long Island	21.94	0.86	0.40	23.20
29 Pennsylvania	26.21	1.11	0.53	27.85
30 Cent.R.R.of New Jersey(Inc.CRRPa)	30.46	1.29	0.56	32.31
31 Reading	23.56	0.98	0.50	25.04
32 Western Maryland	28.14	1.63	0.59	30.36
33 Wheeling & Lake Erie	15.99	1.20	0.33	17.52
POCAHONTAS REGION:				
34 Chesapeake & Ohio	24.55	1.22	0.49	26.26
35 Norfolk & Western	35.20	1.67	0.76	37.63
36 Richmond, Fred'burg & Potomac	38.90	1.86	0.70	41.46
37 Virginian	27.87	2.75	0.66	31.28
SOUTHERN REGION:				
38 Atlantic Coast Line	19.55	0.61	0.32	20.48
39 Clinchfield	25.21	1.45	0.52	27.18
40 Louisville & Nashville	20.06	0.54	0.45	21.05
41 Nashville, Chattanooga & St. Louis	22.90	0.60	0.52	24.02
42 Florida East Coast	25.39	1.19	0.43	27.01
43 Gulf, Mobile & Ohio	23.66	1.73	0.57	25.96

Table II

SPECIFIED ELEMENTS OF TRAIN HOUR COST PER ROAD FREIGHT TRAIN HOUR - YEAR 1946
(Excluding road freight train crews' wages)

Railroad	Elements of train hour cost (per road freight train hour)			
	Fuel, supplies, enginehouse expense and locomotive repairs	Road freight loco- motive depre- ciation	Payroll taxes on labor applicable to road freight loco. repairs & enginehouse expense <u>a</u>	Total train hour cost (excluding train crew wages)
1	2	3	4	5=2+3+4
Item number in report	Items 2 to 8	Item 9	Item 11	Items 2 to 11
<u>NORTHWESTERN REGION:</u>				
52 Minneapolis, St. Paul & S.S. Marie	\$12.02	\$0.31	\$0.18	\$12.51
53 Chicago & North Western	19.22	1.20	0.38	20.80
54 Chicago, St. Paul, Minpls. & Omaha	17.98	0.67	0.28	18.93
55 Chicago Great Western	19.97	0.86	0.35	21.18
56 Chicago, Milwaukee, St. Paul & Pac.	19.96	0.97	0.34	21.27
57 Duluth, Missabe & Iron Range	42.35	1.06	0.87	44.28
58 Great Northern	23.05	1.01	0.48	24.54
59 Minneapolis & St. Louis	14.09	1.08	0.32	15.49
60 Northern Pacific	22.08	0.94	0.48	23.50
61 Spokane, Portland & Seattle	17.03	0.71	0.27	18.01
<u>CENTRAL WESTERN REGION:</u>				
62 Atchison, Topeka & Santa Fe	24.76	1.12	0.53	26.41
63 Alton	21.60	0.63	0.47	22.70
64 Chicago, Burlington & Quincy	15.97	0.99	0.27	17.23
65 Colorado & Southern	21.84	0.60	0.38	22.82
66 Fort Worth & Denver City	18.55	0.80	0.35	19.70
67 Denver & Rio Grande Western	36.00	1.57	0.88	38.45
68 Rock Island System	19.47	0.85	0.37	20.69
69 Northwestern Pacific	14.31	0.31	0.27	14.89
70 Southern Pacific	33.27	0.87	0.75	34.89
71 Union Pacific	34.62	1.27	0.61	36.50
72 Western Pacific	30.80	1.06	0.71	32.57
<u>SOUTHWESTERN REGION:</u>				
73 Frisco Lines	22.94	0.84	0.47	24.25
74 Kansas City Southern	28.14	0.97	0.54	29.65
75 Louisiana & Arkansas	19.89	0.68	0.38	20.95
76 Missouri-Kansas-Texas	18.46	0.75	0.34	19.55
77 Gulf Coast Lines	16.64	0.31	0.31	17.26
78 International-Great Northern	20.49	0.46	0.40	21.35
79 Missouri Pacific	19.96	0.88	0.41	21.25
80 Texas & Pacific	28.03	1.67	0.61	30.31
81 St. Louis Southwestern	20.65	0.95	0.41	22.01
82 Texas & New Orleans	21.36	0.58	0.44	22.38
Composite Average	24.41	1.04	0.50	25.95
<u>AVERAGES BY REGIONS:</u>				
New England	24.23	1.05	0.51	25.79
Great Lakes	25.94	1.33	0.51	27.78
Central Eastern	24.89	1.05	0.53	26.47
Pocahontas	28.89	1.52	0.60	31.01
Southern	22.51	0.83	0.47	23.81
Northwestern	20.15	0.95	0.39	21.49
Central Western	27.36	1.04	0.56	28.96

INSTALLATIONS OF TRAIN OPERATION BY SIGNAL
INDICATION* WITHOUT TRAIN ORDERS, IN THE
UNITED STATES JANUARY 1, 1948†

Method of directing trains	No. of railroads	Road	Miles of Track
One-direction operation by signal indication:			
(a) Centralized traffic control.....	7	59.9	181.7
(b) Manual block.....	15	1,728.7	2,494.4
(c) Controlled manual block.....	2	7.7	9.5
(d) Automatic block.....	61	12,275.9	28,236.4
Either-direction operation by signal indication:			
(e) Centralized traffic control.....	61	8,661.1	9,698.7
(f) Controlled manual block.....	14	202.4	211.6
(g) Automatic block in both directions	53	2,500.1	3,324.0
(h) Automatic block in one direction, traffic locking, reverse direction	22	241.6	473.4
Total reported by 99 railroads.....		25,677.4	44,629.7

Action Recommended

Acceptance as information.

* Interstate Commerce Commission Tabulation of Statistics.

† Revision of Table IX appearing on page 43 of Chapter III—Principles and Economics of Signaling, American Railway Signaling Principles and Practices.

TYPES OF PROTECTION AT RAILROAD HIGHWAY GRADE
CROSSINGS*, DECEMBER 31 OF EACH YEAR†

Type of protection	1944	1945
Gates.....	4,087	4,108
Watchmen.....	4,770	4,717
Signals.....	24,354	25,096
Total protected crossings.....	33,211	33,921
Fixed signs.....	184,359	184,015
Otherwise unprotected.....	8,787	8,817
Grand total.....	226,357	226,753

Action Recommended

Acceptance as information.

* I.C.C. "Statistics of Railways in the United States."

† Revision of Table XX appearing on page 75 of Chapter III—Principles and Economics of Signaling, American Railway Signaling Principles and Practices.

CROSSINGS EQUIPPED WITH GATES, WATCHMEN AND
SIGNALS,* DECEMBER 31, 1945†

Type	Number	Total
Gates, with or without other protection operated 24 hours per day.....	2,988	
Gates, with or without other protection operated less than 24 hours per day.....	1,120	4,108
Watchmen, alone or with protection other than gates, on duty 24 hours per day.....	1,330	
Watchmen, alone or with protection other than gates, on duty less than 24 hours per day.....	3,387	4,717
Both audible and visual signals, without other protection.....	12,391	
Audible signals only.....	2,700	
Visual signals only.....	9,405	24,496
Total protected crossings.....		33,321

Action Recommended

Acceptance as information.

* I.C.C. "Statistics of Railways in the United States."

† Revision of Table XXI appearing on page 76 of Chapter III—Principles and Economics of Signaling, American Railway Signaling Principles and Practices.

INTERLOCKINGS IN THE UNITED STATES*
JANUARY 1, 1948†

Interlockings on line of reporting railroad.....	6,730
Interlockings maintained by reporting railroad.....	4,503
Railroads reporting.....	223
Automatic.....	435
Electric.....	1,661
Electro-mechanical.....	395
Electro-pneumatic.....	430
Mechanical.....	1,502
Pneumatic.....	3
Other types.....	77
Total.....	4,503
Remotely controlled.....	607

Action Recommended

Acceptance as information.

* Interstate Commerce Commission Tabulation of Statistics.

† Revision of Table V appearing on page 31 of Chapter III—Principles and Economics of Signaling, American Railway Signaling Principles and Practices.

CENTRALIZED TRAFFIC CONTROL INSTALLATIONS IN THE UNITED STATES* AND CANADA

JANUARY 1, 1948†

Railroad	No. of instal- lations	Road Miles of Track	No. of passing tracks	No. of controlled Switches	Signals	No. of automatic signals	
A. T. & S. F.	15	659.3	693.6	130	354	889	505
A. C. L.	2	11.3	19.7	—	29	48	4
B. & O.	3	103.9	105.5	27	64	155	73
B. & L. E.	1	49.9	88.6	—	13	58	—
B. & G.	1	16.3	16.3	6	3	49	7
B. & M.	19	164.5	331.7	31	468	448	267
C. N.	4	192.5	220.7	39	116	296	97
C. P.	10	34.1	34.1	1	3	57	20
C. of Ga.	5	58.7	59.8	14	18	87	38
C. R. R. of N. J.	1	4.4	17.6	—	4	10	14
C. & O.	27	423.1	491.7	58	231	635	274
C. & E. I.	1	117.2	117.2	16	29	109	66
C. & N. W.	4	10.2	10.2	1	7	31	10
C. B. & Q.	23	675.8	719.3	88	293	993	322
C. G. W.	2	2.7	2.7	2	3	13	—
C. M. St. P. & P.	17	400.9	469.3	57	118	454	184
C. R. I. & P.	16	500.9	648.8	77	141	603	444
D. & H.	8	58.4	109.8	2	92	129	103
D. L. & W.	1	6.2	7.4	1	4	10	7
D. & R. G. W.	5	466.1	488.6	99	223	802	250
D. M. & I. R.	1	11.9	17.2	—	16	46	20
Erie.	17	137.0	156.7	15	42	176	95
G. T. W.	1	5.3	5.3	—	—	4	7
G. M. & O.	5	59.4	59.4	7	16	68	34
I. C.	7	60.3	63.6	6	27	113	54
K. C. S.	1	46.1	46.1	7	18	51	21
L. & N. E.	1	1.3	1.3	—	3	9	—
L. V.	2	12.5	12.5	—	2	13	9

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Com. I—Economics of Ry. Signaling

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* Interstate Commerce Commission Table of Statistics.

† Revision of Table XIV appearing on page 54 of Chapter III—Principles and Economics of Signaling, American Railway Signaling Principles and Practices.

CENTRALIZED TRAFFIC CONTROL INSTALLATIONS IN THE UNITED STATES AND CANADA
JANUARY 1, 1948—Continued.

Railroad	No. of instal- lations	Road	Miles of Track	No. of passing tracks	Switches	No. of controlled Signals	No. of automatic signals
L. & N.	9	533.0	533.0	73	134	589	301
M. St. P. & S. Ste. M.	4	7.1	7.1	1	4	30	5
M. K. T.	4	15.0	15.0	5	5	44	18
M. P.	45	571.4	694.5	100	302	1,206	449
Mn. Br. St. L.	1	3.4	6.8	—	30	32	47
N. C. & St. L.	4	333.0	337.7	70	152	558	278
N. Y. C.	4	59.4	65.9	9	65	119	46
N. Y. C. & St. L.	8	205.1	210.3	37	84	359	140
N. Y. O. & W.	3	11.4	11.4	—	2	11	9
N. Y. S. & W.	1	1.5	1.5	1	—	3	—
N. & W.	17	402.6	449.3	77	269	863	231
N. P.	3	51.8	52.8	14	26	78	56
P. R. R.	25	377.7	411.8	46	165	405	184
P. & P. U.	1	7.1	14.2	2	19	30	—
Reading	1	—	2.7	—	3	5	1
St. L.-S. F.	7	197.8	217.1	36	79	409	159
St. L. S. W.	5	184.0	196.9	24	57	255	123
S. A. L.	7	332.9	354.9	78	187	506	233
Sou. (C. N. O. & T. P.)	1	18.8	23.3	4	11	30	17
S. P.	16	404.0	413.4	109	298	1,145	446
T. & P.	14	173.9	209.0	27	70	378	160
U. P.	6	633.4	673.4	138	296	1,071	483
Virginian	1	57.8	57.8	8	16	66	52
Wabash	4	71.6	76.9	12	49	135	51
W. P.	1	114.6	114.6	27	54	164	50
W. & L. E.	2	60.0	60.0	7	18	59	46
Total	394	9,118.5	10,226.0	1,589	4,732	14,906	6,510

Action Recommended
Acceptance as information.

ECONOMICS OF USE OF CAPACITORS IN SIGNAL POWER LINES

Previous reports* have been presented by this Committee on the "Economics of the use of capacitors in signal power lines." This presentation deals with the actual methods used in correcting the power factor on one railroad and lists the advantages gained.

The power transmission system selected for power factor correction was a three-phase, delta-connected, 60-cycle, 4600-volt line, 99 miles long, with the substation located at the geographical center. The line consisted of three No. 4 copper wires approximately 5 feet apart, arranged in triangular configuration. The load on the line was equally divided among the three phases and consisted of functions as listed in Table I.

Before any power factor improvement is undertaken it is necessary to make preliminary measurements of load conditions to determine the type and amount of improvement necessary. This is best done by separating high and low power factor loads, and continuous and intermittent loads. Each type of load can then be treated individually.

Signal Loads

To determine the power and power factor of the normally-connected signal load all lighting and motor loads were disconnected from the line, and the following readings taken:

1. One of the potential elements of the two-element watt-hour meter was disconnected. The speed of the disc was noted and found to be 2 revolutions per minute.
2. This element was reconnected and the other potential element disconnected. The revolutions of the disc were then found to be 24 per minute. The "two watt-meter" formula for determining power factor is:

$$\text{Power factor} = \frac{1 + R}{2 \sqrt{1 - R + R^2}} \quad (1)$$

where R is the ratio of the speed of the slower disc to that of the faster. In this case $R = \frac{+2}{+24} = +0.0833$. Substituting this value of R in the formula

gives a power factor of 56.4 per cent. The relationship between disc speed ratio and power factor has been plotted graphically in Fig. 1 and the solution may be read from this curve with reasonable accuracy.

The power factor of 56.4 per cent for the signal load indicated that correction would be advisable. The next step consisted in determining the size of capacitors required and deciding upon their proper distribution and location. Before this was done a reactive kilovolt ampere-hour meter was installed by the power company as a necessary part of their metering equipment when supply-

* A.A.R. Signal Section 1944 Proceedings, Vol. XLII, p. 34-A and 1945 Proceedings, Vol. XLIII, p. 60.

TABLE I
Electrical Characteristics of Connected Loads

Functions	No. of units	Volts per unit	Amps. per unit	Volt- amps. per unit	Watts per unit	Total volt- amps.	Uncor- rected power factor	Total watts	VARs or reac- tive volt- amps. per unit	Total VARs required to raise power factor to 100%	Total VARs required to raise power factor to 95%
1-arm position light signals....	111	115	2.67	307	169	34077	0.55	18759	256	28416	
2-arm position light signals....	72	115	3.48	400	220	28800	0.55	15840	334	24048	
1-KVA line transformers.....	159	115	0.56	65	46	10335	0.71	7338	46	7314	
Yard lights.....	8	110	9.09	1000	1000	8000	1.00	8000			
Station and other lights.....	8	110	4.00	440	440	3520	1.00	3520			
Totals.....						84732		53457		59778	
10 h.p. 220-v. 3-phase motors	2	220	24.6	9363	7490	18726	0.80	14980			6400

ing energy on a power factor basis. The reactive meter is usually identical with the kilowatt-hour meter except that it is connected through a phase-displacement transformer so that only the wattless energy, or reactive kilovolt ampere-hours, will be registered.

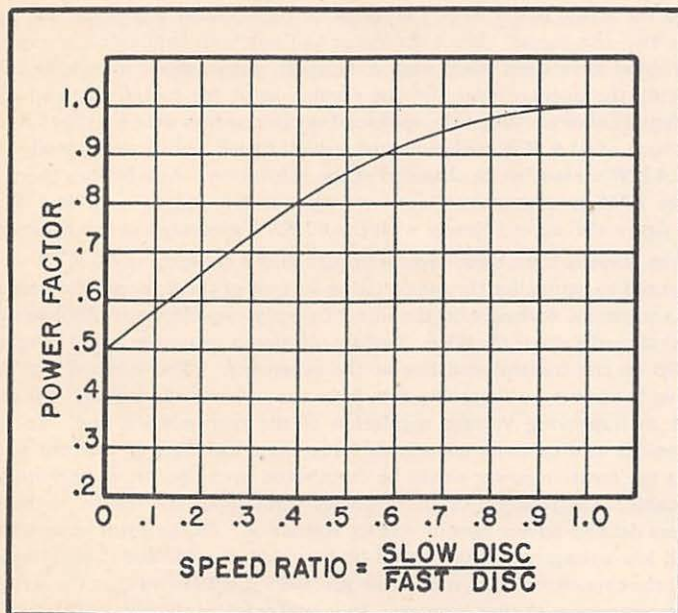


FIG. 1

With the reactive meter in service the time required for 10 revolutions of the disc of the active meter was found to be 58 seconds, or 5.8 seconds per revolution. The time required for 10 revolutions of the disc of the reactive meter was 40 seconds, or 4 seconds per revolution. To determine the active and reactive power the following formula was used:

$$KW = \frac{P \times C \times Kh \times 3.6}{T} = \frac{20 \times 5 \times 2/3 \times 3.6}{5.8} = 41.4 \text{ KW (2)}$$

Where P = Potential transformer ratio

C = Current transformer ratio

Kh = Meter constant, or watt-hours for one revolution of meter disc

T = Time in seconds for one revolution of meter disc

A similar calculation based on the reactive meter readings indicated 60.0 kilovars, or 60.0 KVA reactive power.

Before actually attempting power factor correction, the above figures were checked by measurements made at typical signal locations. Voltage readings taken at the entrance switches averaged 115 volts. The current at the signal locations averaged 2.67 amperes for one-arm signals and 3.48 amperes for two-arm signals. This gave an average of 307 and 400 volt-amperes for one-arm and two-arm signals respectively. A watt-meter connected in the circuit showed the actual power to be 159 watts for the one-arm signal and 220 watts for the two-arm signal. If a watt-meter had not been available the measurements could have been made with a 115-volt, single-phase watt-hour meter by noting the average time for one revolution of the meter disc and using equation (2) above. When the spot load measurements were averaged a total signal load of 41.9 KW was indicated, which figure agreed very closely with the 41.4 KW measurement obtained at the substation. As a further check the reactive KVA measurements were averaged and found to total 59.7 KVA, which figure also agreed closely with the 60 KVA measured at the substation.

It was obvious from these measurements that a capacity of 60 KVA would be required to neutralize the magnetizing current of the line transformers and signal equipment normally on the line. In early capacitor installations made by the railroad a single 60 KVA, 3-phase, 4600-volt capacitor would have been installed on the transmission line at the substation. This method was fully effective in securing a favorable rate from the power company but was of no benefit in improving voltage regulation of the transmission line. In later installations two or more capacitors have been installed at selected points so that the reactive power would be distributed over the line as uniformly as practicable. Distribution of the capacity throughout the length of the line produces definite advantages in voltage regulation. In the ideal arrangement a small low-voltage capacitor would be provided at each line transformer location, the capacity of each unit being just sufficient to neutralize the wattless current component at that location. In actual practice the cost of this method is so much higher than the cost of grouping a few high-voltage capacitors that a compromise is generally found to be most effective. In the example under consideration four 15 KVA, 4600-volt, 3-phase capacitors were distributed along the line in such a way as to produce the best voltage regulation.

There are other advantages in distributing capacity. It is sometimes desirable to transfer a power source from one point to another. This may be necessitated by failure of one source, the securing of a more favorable rate at another location, or may be required by reason of line or equipment failures or repairs. Where capacity has been reasonably well distributed the source may be transferred at any time without loss of efficiency and without any change in capacitors. A further advantage of distributing capacity is improved continuity of service. If all capacity is grouped in a single unit, a failure such as a blown fuse will remove all power factor correction. With capacity distributed between four units as in the line under consideration, failure of one unit will permit continued operation with reasonably good power factor and voltage regulation.

Good voltage regulation is necessary in order that connected equipment may operate with maximum reliability. Good voltage regulation is also an indication that I^2R losses on the transmission line are a minimum. These losses absorb power that produces no useful work but that must be paid for.

TABLE II
Costs of Capacitor Installations

	Capacitor voltage	Size of capacitor	Phases	No. of capacitors required	Installed cost per capacitor	Total cost of installation	Monthly saving in power bill	Annual saving in power bill	Annual return on investment
Plan A.....	120	0.5 KVA	1	120	\$ 12.65	\$1601.00	\$85.66	\$1027.92	64%
	230	2.5 KVA	3	2	41.50				
Plan B.....	4800	15 KVA	3	4	172.95	774.80	85.66	1027.92	133%
	230	2.5 KVA	3	2	41.50				
Plan C.....	4800	60 KVA	3	1	478.45	478.45	85.66	1027.92	215%

Proper distribution of capacitors reduces line current to a minimum and consequently reduces line losses to a minimum. In addition to the actual saving in power bills the reduced losses improve voltage regulation and in some instances make it possible to operate devices that otherwise could not be operated on a line of similar length. On a certain transmission line a minimum secondary voltage of 95 at the far end of the line was not unusual. This voltage was not sufficient to operate signal apparatus reliably. Installation of capacitors raised this minimum voltage 10 volts and made it unnecessary to provide an additional power source. Table II shows costs and savings in connection with various types of capacitor installations. It will be noted from this table that the lumping of all installed capacity at one point is the most economical arrangement as far as return on investment is concerned. Such an arrangement, however, does not necessarily produce better voltage regulation on the line itself nor does it permit any appreciable increase in line capacity. In many instances economies resulting from improved regulation and increased capacity will more than justify the increased investment resulting when capacitors are distributed along the line.

Motor Loads

The problem of determining capacitor requirements in connection with motor loads is usually quite different from that encountered with signal loads. It was for this reason that all motor loads were disconnected for the preliminary measurements. Signal loads are normally permanently connected to the line and consequently the capacitor which neutralizes the magnetizing current of signal loads can also be permanently connected to the line. Large motors generally operate only a part of the time; consequently if capacitors are installed in connection with such loads the capacitors should be effective only when the motor is operating. This is a further argument against grouping all required capacity.

Load check tests were made on the 220-volt, 3-phase motors connected to the transmission line under discussion. It was found that in this particular instance each motor had an actual load of 7.46 KW. The normal voltage was 220 and the current per phase, 24.6 amperes. The apparent power was therefore:

$$\frac{\sqrt{3} \times E \times I}{1000} = \frac{\sqrt{3} \times 220 \times 24.6}{1000}$$

or 9.36 KVA. The power factor is the actual power divided by the apparent power (7.46/9.36) or 79.7 per cent.

Figure 2 shows a graphical solution of this problem. The power factor plotter shown in Fig. 3 will be found very helpful in problems of this kind. On the base of the triangle the 7.46 KW actual power is plotted horizontally. The 9.36 KVA apparent power is plotted, on the same scale, as the hypotenuse of the triangle. The resulting vertical component of 5.65 RKVA is the reactive power and represents the capacity that would be required if the motor were corrected to 100 per cent power factor.

It is generally considered not advisable to correct the power factor of a motor to better than 95 per cent lagging. With higher power factor there is a possibility of internal stresses in the motor which have been known, under certain conditions, to be great enough to twist the armature or shear the shaft connecting the motor to its load.

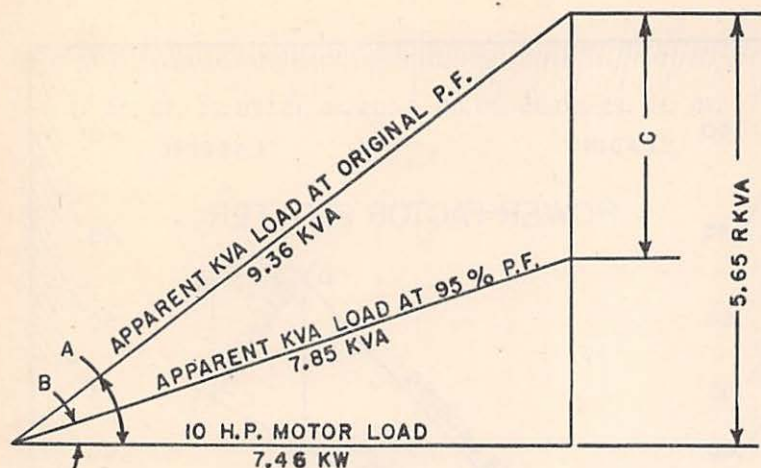


FIG. 2 VECTOR DIAGRAM TO DETERMINE SIZE OF 3-PHASE 220V. CAPACITOR FOR 10 HP MOTOR.

In order not to exceed the 95 per cent power factor, usually considered as a safe maximum, an apparent power of 7.85 KVA ($7.46 \div 0.95$) is laid off as the hypotenuse of another triangle on the same base. That part of the vertical component, indicated by "C," represents the capacity necessary to raise the power factor from the original uncorrected figure of 79.7 per cent to the desired figure of 95 per cent. In this particular instance the theoretical desired capacity is 3.2 KVA. The nearest commercial size available was 2.5 KVA and this size was installed, producing a resulting power factor of 92 per cent. This capacitor was installed on the load side of the starting compensator so that it would not be on the line except when actually desired to neutralize the magnetizing current of the motor.

It would have been possible to combine this motor capacity with the capacitors normally installed on the line and this arrangement would have reduced the total first cost of the power factor correction program. If this had been done the average operating time of the motor would have been noted. If it had been found that the motor operated 50 per cent of the time then 1.6 KVA, or 50 per cent of the calculated capacity of 3.2 KVA, would have been added to the total connected capacity. Over a period of time this capacity would have balanced the magnetizing current, and the power requirements as indicated by the metering equipment would be neither more nor less than with the individual capacitor. The effect on the transmission line, however, would not be favorable because with the motor operating the power factor would be excessively low and the voltage regulation adversely affected. With the motor idle power factor correction would be excessive and voltage regulation again would be adversely affected.

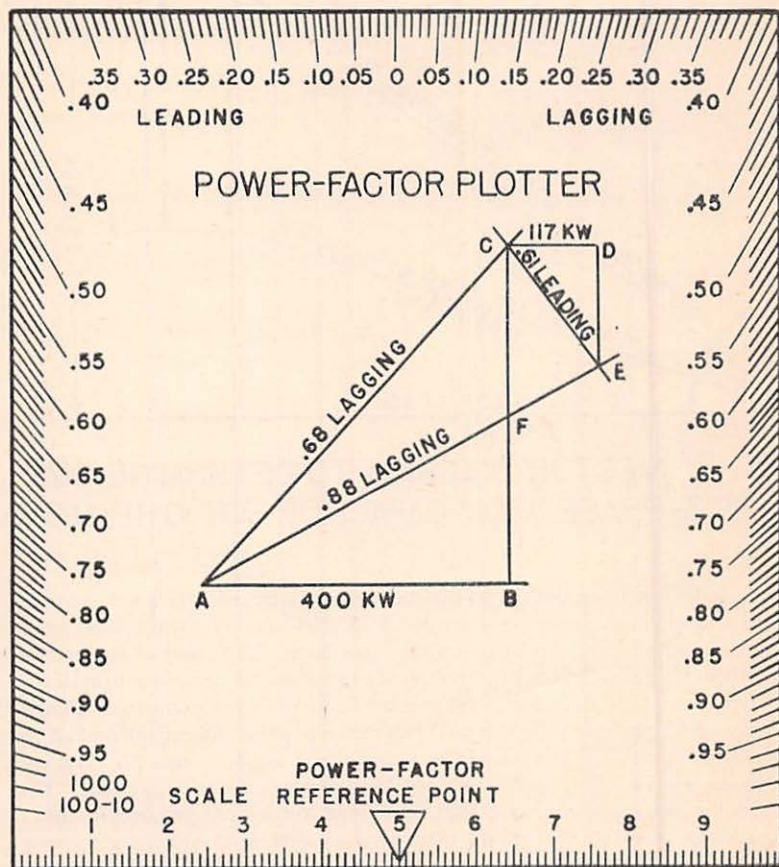


FIG. 3

Lighting Loads

Lighting and heating loads on transmission lines usually have a power factor so near unity that they may be neglected. Transformers and reactors used in connection with certain types of lighting may draw some magnetizing current. Control equipment on heaters may do the same, but generally these effects may be neglected. The usual effect of increased lighting load is to raise the over-all power factor due to the fact that the lagging current feeding other loads becomes a smaller proportion of the total current.

Economics of Power Factor Correction

In order to point out the appreciable savings resulting from taking advantage of power factor rates offered by many power companies a comparative statement of billing before and after power factor correction is shown in Table III. The figures used are actual and apply to the transmission line in the foregoing discussion. As billing practices vary with different companies some explanation of this particular schedule may be necessary. It will be noted that the power factor was increased from 62.7 per cent to 100 per cent. The power factor constant is a multiplier used by the power companies as a premium or penalty depending upon whether the power factor is favorable or unfavorable. Before correction the power factor was 62.7 per cent. The power factor constant of 1.1499, applying to a power factor of 62.7 per cent, was used to multiply the actual consumption of 35,837 KWH. The resulting corrected figure of 41,209 KWH is the figure actually billed. With 100 per cent power factor a constant of 0.951 is used and this multiplier corrects the billing figure to 34,081, or less than that actually used. The billing demand in KVA is recorded by a demand meter installed as part of the metering equipment. It will be noted that after power factor correction the monthly bill was reduced \$85.66.

Table II gives comparative figures for three possible arrangements of power factor correction. Plan "A" is based on the use of low-voltage capacitors at

TABLE III

Comparison of Power Bills

	Before correction	After correction
Period covered.....	30 days	30 days
Power factor.....	62.7%	100%
KWH meter reading.....	35,837	35,837
RKVAH meter reading.....	44,396	0
Power factor constant.....	1.1499	0.951
Corrected figure.....	41,209	34,081
Billing demand—KVA.....	79	61
Billing blocks:		
(1) 30 hours of billing demand—KWH.....	2,370	1,830
(2) 170 hours of billing demand—KWH.....	13,430	10,370
(3) 160 hours of billing demand—KWH.....	12,640	9,760
(4) Excess of 360 hours of billing demand—KWH.....	12,769	12,121
Calculation of charges:		
1st billing block @ 4.25¢ per KWH.....	\$100.72	\$77.78
2nd billing block:		
3,000 KWH @ 2.0¢.....	60.00	60.00
3,000 KWH @ 1.8¢.....	54.00	54.00
4,000 KWH @ 1.6¢.....	64.00	64.00
Remaining portion @ 1.4¢.....	48.02	5.18
3rd billing block @ 0.6¢ per KWH.....	75.84	58.56
4th billing block @ 0.4¢ per KWH.....	51.08	48.48
Coal cost adjustment—Total KWH @ 0.075¢.....	26.88	26.88
Net bill.....	\$480.54	\$394.88

each inductive load with a resultant annual return on the investment of 64 per cent. Plan "B" is based on the use of four line capacitors and two motor capacitors. Because of the reduced investment this plan shows a return of 133 per cent. Plan "C," using a single large capacitor, shows the lowest investment cost and the largest return on the investment. It must be remembered, however, that this latter plan does not improve line voltage regulation, reduce line losses, or offer other advantages that in some instances might offset increased savings.

The advantages of the power factor correction may be summarized as follows:

- (a) Direct reduction in power bills as a result of more favorable power rates.
- (b) Reduction in size of transformers required at substations due to decreased current requirements.
- (c) Reduction in I²R line losses due to reduction in current. This saving is directly reflected in power bills. It is usually small in comparison with the saving due to more favorable rates but it is not negligible.
- (d) More reliable performance of equipment due to improved voltage regulation.
- (e) Operation of longer transmission lines due to better regulation. This sometimes results in reduction of substations and their investment. It also makes possible the purchase of power in larger blocks at more favorable rates.

Bibliography.

- C. R. Underhill: "Power-Factor Wastes."
- Price L. Rogers: "Power-Factor Economics."
- An article in *Railway Signaling*, September, 1933.
- General Electric Co. pamphlet GET-1306.

Action Recommended

Acceptance as information.

ECONOMICS OF ELIMINATING SIGNAL LINE WIRE

In 1945 cost data was solicited from railroad representatives on Committee I regarding annual maintenance of signal line wire carried on pole line structures. Results so obtained were widely divergent and therefore inconclusive.

Accordingly, the Committee has herein approached the issue by attempting to determine the relationship of annual maintenance costs for one wire mile to the first cost of pole line equated on a wire mile basis.

The following data are submitted:

1947 First Cost of One Mile of Two Cross-arms—20 Wire—Heavy
Loading—Grade 1-B Pole Line Using 40 Class 5 Poles Per Mile

	Unit	Material	Labor	Total
*40 Poles.....	\$ 8.16	\$ 326.40	\$273.20	
84 Cross-arms with hard- ware	3.58	300.72	57.12	
840 Insulators	0.083	69.72	42.00	
20 Mile No. 9 A.W.G. bare copper line wire	60.42	1,208.40	375.60	
10 Anchors and guys	5.64	56.40	81.10	
15 Transposition brackets	0.99	14.85	7.05	
		\$1,976.49	\$836.07	\$2,812.56
Work train—delivering material.....				50.64
				\$2,863.20
Store expense—7% of \$1,976.49.....				138.35
State of Pennsylvania Workman's Compensation (3%) and Liability Insurance (0.35%)—3.35% of \$836.07.....				28.01
				\$3,029.56
Engineering and Contingencies—15% of \$3,029.56.....				454.43
**Total.....				\$3,483.99

* Mile of pole line, included 1 road crossing—consisted of:

20—18 ft. poles	4—30 ft. poles
7—20 ft. poles	2—35 ft. poles
5—25 ft. poles	2—40 ft. poles

** Railroad Retirement Tax (5.75%) and Unemployment Insurance (3.00%) not included in above capital project as these items were charged to Tax Accounts.

1947 Annual Maintenance Costs per Mile
for Equivalent Pole Line Built in 1920

Pole replacements and heavy maintenance.....	\$166.00
Day to day maintenance.....	68.00
Total.....	\$234.00

\$234.00 ÷ 20 = \$11.70 maintenance cost per wire mile per annum.

The first cost of pole line structure expressed on a wire mile basis is:

$$\$3,483.99 \div 20 = \$174.20 \text{ per wire mile}$$

The relation of annual maintenance costs per wire mile to first cost of such wire in place on pole line structure (total cost of structure equated on wire mile basis) is:

$$\$11.70 \div \$174.20 = 6.7\%$$

These figures may be considered typical for pole lines carrying 2 cross-arms with 20 wires. For lines larger or smaller, the figures will vary appreciably, but not in direct proportion to number of wires.

Action Recommended

Acceptance as information.

FREIGHT TRAIN TIME SAVED WHERE TRAINS ARE OPERATED BY SIGNAL INDICATION

A.A.R. Signal Section 1936 Proceedings, Vol. XXXIV, pp. 58-60, contain a list of 19 centralized traffic control and remote control installations where the freight train time savings varied from 0.27 to 4.29 minutes per freight train mile with an average of 1.38 minutes. Two additional installations were reported in A.A.R. Signal Section 1940 Proceedings, Vol. XXXVIII, pp. 11 and 12; one additional installation in A.A.R. Signal Section 1941 Proceedings, Vol. XXXIX, p. 12 and six additional installations in A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, p. 63.

The Committee now submits information on 13 additional installations:

Rail- road	Miles		Avg. frt. trains per day	Max. trains per day	Av. frt. train time saved per trip, minutes	Per cent time saved	Minutes saved per frt. train mile
Road	Track						
A	53.0	53.0	16.3	27	88.0	33.3	1.66
B	47.0	62.0	49.1	65	53.0	15.8	1.13
C	121.4	122.7	37.0	43	74.3	25.2	0.61
D	84.8	95.3	23.3	33	48.5	18.5	0.57
E	33.7	33.7	18.0	24	14.5	13.9	0.43
F	68.0	72.0	24.7	48	33.0	15.7	0.49
G	42.0	45.0	27.6	42	22.0	18.5	0.52
H	43.0	45.0	39.7	58	60.0	33.1	1.40
I	111.0	115.0	30.0	50	105.0	26.4	0.95
J	92.0	92.0	20.0	30	57.0	25.6	0.62
K	127.2	131.9	20.0	40	70.0	19.9	0.55
L	86.6	86.6	19.3	30	52.0	22.7	0.60
M	52.7	57.7	22.0	25	25.0	10.0	0.47

The average saving for the 13 installations amounted to 0.76 minutes per freight train mile.

The reports submitted to date cover 41 installations with a road mileage of 2,150, showing an average saving of 0.94 minutes per freight train mile.

Action Recommended

Acceptance as information.

ECONOMICS OF USE OF YARD TRACK INDICATORS

The reporting railroad installed a yard track indicator at a terminal located at one end of a 125 mile centralized traffic control installation.

At this terminal the west switch is 7,200 feet west of the yard office.

Prior to the installation of centralized traffic control, eastward trains were advised by message delivered by the operator at a station three sidings west of the terminal, the track which the train was to enter on arrival at the terminal.

After centralized traffic control was installed, the outlying station was closed and eastward trains had to stop at west end of yard lead and contact yard office by telephone to ascertain which track to enter.

This practice delayed entering trains on an average of 5 minutes each and often caused delay to westward trains due to the eastward train still occupying the "OS" section when making the stop to use the telephone.

The indicator was arranged for 10 track indications and controlled by coded control system, operating on two wires on the signal pole line from the yard office to the west end "OS" section.

The indicator is lighted only while "OS" section is occupied.

Average eastward train movements per day is 12, or 4,380 per annum. With an average time saving of 5 minutes per train this amounts to an annual time saving of 365 train hours. No credit is taken for eliminating delays to westward trains.

Economic Statement

1. Cost of Installation:		
(a) Capital Investment.....	\$4,596	
(b) Operating Expenses.....	180	
(c) Total.....		\$4,776
2. Gross Saving per Annum.....		\$9,063
3. Increased Annual Operating Expenses.....		20
4. Net Reduction in Annual Operating Expenses.....		\$9,043
5. Deduction for Interest Charges, 6% of \$4,596.....		276
6. Net Saving per Annum.....		\$8,767
7. Annual Return over 6% Interest:		
(a) On Capital Investment ($6 \div 1-a$).....		190%
(b) On Total Cost ($6 \div 1-c$).....		183%

Action Recommended

Acceptance as information.

**ECONOMICS OF CENTRALIZED TRAFFIC CONTROL
BETWEEN LAS VEGAS AND CALIENTE, NEV.,
UNION PACIFIC R.R.**

The Union Pacific R.R. operates a single-track main line from Los Angeles, Calif., to Salt Lake City, Utah, a distance of 784 miles, except for 101 miles of joint two main tracks with the Santa Fe between Riverside and Daggett, Calif. The line from Las Vegas to Caliente, 125.3 miles, extends northeast from Las Vegas through a desert mountainous territory at an elevation of 2,027 feet at Las Vegas and 4,390 feet at Caliente. There are numerous curves up to 8 degrees and a maximum helper grade of 1.5 per cent. The 25 sidings varied in capacity from 73 to 123 cars, six of the sidings being over 100 cars. Rail is 131 pound and turnouts are No. 10.

Prior to the centralized traffic control installation on February 28, 1945, trains were governed by time-table, train orders and automatic block signals. The daily traffic for the month of April 1945 was as follows:

Streamliners.....	0.7
Passengers.....	9.0
Through freights.....	19.6
Locals.....	1.7
Helpers.....	4.1
Total.....	35.1

The freight train miles in 1944 were 821,553 compared to 826,287 in 1945. The gross tons one mile, all trains, were 1,895,785,343 in 1944 compared to 1,920,803,410 in 1945. The average gross tons per freight train in 1945 was 1,858 tons eastward and 2,776 tons westward, an average of 2,325 tons.

The track changes included adding 11,630 feet of track for longer sidings, wye track, yard track, etc. The signal changes included 1.3 miles of new automatic signals in yards, 53 power switches, 9 electric locks, 161 motor car indicators, 64 telephones, and 60.9 miles of new signal pole line.

A study was made of train operations for a month, January 1944, with train orders, as compared to April 1945, with centralized traffic control. A brief summary is as follows:

Item	Increase	Decrease
1. Average trains per day.....		0.9
2. Gross tons hauled in through freights per month:		
E.....	100,391	
W.....	74,607	
3. Average cars per through freight train:		
E.....	6	
W.....	3.3	
4. Average tons per through freight train:		
E.....	261	
W.....	158	

Item	Increase	Decrease
5. Average road time per through freight train in minutes:		
E.....		122.4
W.....		82.2
Locals.....		47.1
Helpers Las Vegas.....		173.6
Caliente.....		89.2
6. Average initial terminal time per through freight train, minutes per trip:		
E.....		41.5
W.....		38.9
Locals.....		28.9
Helpers Las Vegas.....		19.2
Caliente.....		22.2
7. Overtime saved per trip, minutes:		
Through freights.....		33.6
Locals.....		61.3
Helpers Las Vegas.....		76.3
Caliente.....		31.3
8. Train miles saved per month:		
Through freights.....		4,000
Helpers.....		5,228
9. Locomotive saving.....		6
10. Car days saved per year.....		32,850
11. Train stops saved per year.....		88,330
12. Man hours saved per year.....		171,575

Action Recommended

Acceptance as information.

COMMITTEE II—INTERLOCKING

Personnel

D. W. Fuller, Chairman

H. A. Hudson, Vice-Chairman

B. J. Alford	W. G. Salmonson
E. T. Ambach	T. C. Seifert
R. B. Amsden	V. P. Shepardson
C. F. Brooks	A. M. Smith
J. J. Clancy	R. W. Troth
L. Cone	C. M. Wallace
C. M. Duffy	W. Welsh
W. A. Ford	J. W. Whippo
C. F. Grundy	J. F. Yerger
K. L. Muse	G. A. Ziehlke

F. J. Ackerman*

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Collaborate with A.R.E.A. Committee 5 on switch, frog and crossing layout plans, in order to make layouts as universal as possible for the application of signals and interlocking, including location of insulated rail joints in turnouts, crossovers and crossings.
4. Prepare typical plans for interlocked and spring switch layouts.
5. Investigate and report on maximum permissible speed, trailing through closed point of spring switch with respect to:
 - (a) Buffer limitations on non-facing point lock types.
 - (b) Buffer and mechanism limitations on mechanical facing point lock types.
6. Investigate and report on the use of swivel type vertical front rods for spring switches, interlocked switches, and movable point frogs.
7. Requisites for yard track indicators.
8. Specification for car retarder control machine.
9. Specification for electric car retarder mechanism.
10. Specification for electro-pneumatic car retarder mechanism.
11. Specification for electric switch operating mechanisms for car retarder yards.
12. Specification for electro-pneumatic switch operating mechanisms for car retarder yards.
13. Specification for electric skate operating mechanism.
14. Specification for electro-pneumatic skate operating mechanism.

* Consulting Member.

The Committee submits for consideration, reports on the following subjects*:

6. Use of swivel type vertical front rods for spring switches, interlocked switches and movable point frogs.

7. Requisites for yard track indicators for indicating to a train the track to be entered.

Disposition of 1947 Letter Ballot Subjects

The following subjects presented by this Committee in the 1947 Annual Meeting Advance Notice were submitted to letter ballot and officially approved:

Specification 130-47—Circuit Controller for Movable Bridges—Now in Manual Part 48.

Specification 215-47—Spring Switch Mechanism—Now in Manual Part 225.

USE OF SWIVEL TYPE VERTICAL FRONT RODS FOR SPRING SWITCHES, INTERLOCKED SWITCHES AND MOVABLE POINT FROGS

The assembly comprises an insulated vertical front bar, two bearings and two switch point lugs designed to provide swivel action at both ends of the rod and arranged for suitable adjustment and lubrication for long bearing life.

To determine the extent of use at present and to obtain opinions relative to performance of swivel type vertical front rods on spring switches, interlocked switches and movable point frogs, a questionnaire was sent on January 19, 1948 to 149 Voting Representatives of Member Roads of the Signal Section in the United States and Canada. Replies were received from 106 railroads, which is 71.1 per cent.

Summary of the replies is as follows:

	No. of railroads	No. of votes	Per cent of votes
Questionnaires sent.....	149	1101	100.0
Reply received.....	113	1029	93.5
No reply received.....	36	72	6.5
Information not available.....	3	66	6.0
Total rods reported in service—914.....	30	494	44.9
Railroads reporting no rods in service.....	80	469	42.6

Several railroads reported additional swivel type vertical front rods on order but not in service. The replies from the 30 railroads reporting 914 rods installed show number of switches and movable point frogs equipped and length of time in service as follows:

762 single switches, in service 3 months to 7 years.

35 slip switches, in service 3 months to 3 years.

40 movable point frogs, in service 3 months to 5 years.

77 spring switches, in service 3 months to 5 years.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 17, 1948.

The principal advantages of swivel type vertical front rods applied on spring switches, interlocked switches and movable point frogs as reported are as follows:

1. Especially when used with vertical type switch rods, switch points are held rigidly in vertical position making it easier to meet the $\frac{1}{4}$ inch obstruction test.
2. Permits switch points to be out of alignment without causing initial and subsequent stress in front rod.
3. Reduces friction, eliminates strain and consequently reduces power required to operate switches and movable point frogs.
4. Gives improved service where switch points tend to run.
5. Provides better service than any type of rod previously used on movable point frogs having difficult maintenance conditions.
6. Reduces failures due to breakage of rigid type front rods formerly used.
7. Bolts through switch points do not work loose as readily as they do when rigid front rods are used.
8. Keeps lock rod in adjustment better than rigid front rod.
9. Reduces broken switch feet on spring switches.
10. Contributes to support of switch points in upright position when train is trailing through spring switch.

Action Recommended

Acceptance as information.

A.A.R. SIGNAL SECTION REQUISITES.

YARD TRACK INDICATORS
FOR INDICATING TO A TRAIN THE TRACK TO BE ENTERED

1948

1. *Aspect.*

(a) Yard track indicator aspect shall be provided by an electrically operated sign displaying an illuminated numeral indicating the number of the track to be entered.

(b) The indications shall be distinctive from those displayed by other fixed signals.

(c) The numerals shall be in white figures on a black background.

(d) The numerals, when illuminated, shall give a light visibility range in excess of 300 ft. and "message" legibility range of 200 ft. in bright sunlight through a total horizontal angle of 45 deg.

(e) No numeral shall be displayed when the system is not functioning properly.

(f) Where two or more tracks converge approaching a yard, means shall be provided to indicate to train crews for which train the track number is being displayed.

(g) The numeral shall be legible only when illuminated from inside the housing.

(h) Hood shall be provided over each lamp or group of lamp units.

2. *Location.*

(a) Indicator shall be located to best meet the requirements.

3. *Control.*

(a) Control machine.

1. Selection of numeral to be displayed shall be by lever, toggle switch, selector dial switch or push button.

2. Means shall be provided to indicate which numeral has been selected.

(b) Control circuits.

1. Unit wire control or code control may be used.

2. Only one track number shall be displayed at the same time.

3. Means shall be provided for cancellation of any number displayed before displaying another number.

4. Cancellation of a number displayed may also be automatic upon passage of a train.

Action Recommended

Acceptance for submission to letter ballot.

COMMITTEE III—AUTOMATIC TRAIN CONTROL AND SIGNALS

Personnel

E. S. Taylor, Chairman	
J. P. Kaysen, Vice-Chairman	
H. D. Abernethy	J. F. McConahay
P. P. Ash	W. P. Mink
R. J. Cullen	C. R. Somers
E. B. DeMeritt	H. L. Stanton
J. R. DePriest	W. L. Talevich
D. W. Dower	A. M. Weeks
H. C. Griffith	R. R. Wood
W. W. Hartzell	L. C. Heilman*
E. Lockhart	D. M. Noell*

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Indexing signal literature.
2. Report on Federal, State and Dominion activities on automatic train control, signals, interlocking, highway grade crossing protection, and related safety devices, collaborating with other committees when necessary.
3. Report developments of automatic train control and locomotive cab signals, collaborating with Joint Committee on Train Operation, Control and Signals, A.A.R.
4. Develop statistics indicating by States and railroads the number and types of auto-manual and automatic highway crossing protection installations.

The Committee submits for consideration, reports on the following subjects**:

2. State and Dominion activities.
3. Automatic Train Control and Automatic Cab Signals in the United States as of January 1, 1948.

Show-Cause Orders Issued by the Interstate Commerce Commission Under Paragraph (b) Section 25 of Interstate Commerce Act from August 1946 to December 1947.

Hearings set by the Interstate Commerce Commission under the Signal Inspection Act (Docket 28000) for the year 1947.

I. C. C. Order No. 29543 (June 17, 1947).

I. C. C. Instructions Governing Applications Under Section 25 of the Interstate Commerce Act (March 17, 1947).

Tabulation of Petitions Filed with I. C. C. in Docket No. 29543 (September 23, 1947).

4. Number and types of highway crossing protection installations in the United States.

States issuing annual reports on accidents at railroad-highway crossings.

* Consulting Member.

** Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 17, 1948.

STATE AND DOMINION ACTIVITIES

The following report, which brings the information up-to-date, supersedes report appearing on pages 84-A to 103-A, inclusive, of the 1947 Annual Meeting Advance Notice (A.A.R. Signal Section 1946 Proceedings, Vol. XLIV):

Alabama.

There is no regulation of installation, maintenance or inspection of railway signaling conferred by State statutes.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

Arizona.

The State Corporation Commission has jurisdiction. Section 69-228, effective 1912, pertaining to signals and interlocking and Section 69-229, effective 1912, pertaining to grade crossings give the Commission power to determine and prescribe the location, type, installation and maintenance of signals, interlocking and highway grade crossing safety devices.

This State participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

The State Highway Department places and maintains the reflectorized signs in approach to railway crossings at grade.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

Arkansas.

Section 11074 of Pope's Digest provides that railroads must erect, operate and maintain an automatic block signal system at all tunnels, said block signals to be located at least 2,500 feet from each end of the tunnel.

This State participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

Section 11072 of Pope's Digest provides that railroads shall be required to place and maintain sufficient lights during the nighttime on all its main track switches, and of the color green indicating switch lined for main track movement and the color red to indicate switch lined for side track movement.

California.

General Order 33 (b), March 16, 1936, issued by the Public Utilities Commission, establishes certain requisites for the installation of interlocking. Requires submission of plans for new installations and changes in existing plants.

General Order 75-B, July 17, 1939, issued by the Public Utilities Commission covers regulations governing protection of crossing at grade of roads, highways and streets with railroads. This Order specifies certain types of signals, stipulates warning aspects shall be displayed for approximately 25 seconds, with limits of from 20 to 30 seconds, in advance of the normally fastest train operated over the crossing protected. Provides for approval covering removal, reduction or substitution of protection.

Colorado.

There is no regulation of installation, maintenance or inspection of railway signaling conferred by State statutes.

Reflectorized approach railroad warning signs at grade crossings are furnished, installed and maintained by the local authorities. On Federal Aid Crossing projects, the railroad furnishes and installs the signs, but the items are reimbursable from the participating funds and the contract for each individual project specifically mentions this feature; also the contract provides that maintenance and repair of such signs, is to be the responsibility of either the State, county or city.

Delaware.

Automatic train control:

No State law or regulations.

Signals and interlocking:

There is no regulation of installation, maintenance, or inspection of railway signaling conferred by State statutes.

Practice is generally in accordance with Interstate Commerce Commission Rules, Standards and Instructions, effective September 1, 1939.

Highway grade crossing protection:

No State law or regulations of general application in effect.

A.A.R. standard flashing light signals have been installed without question.

The Revised Code of Delaware, 1935, embodies some requirements for the provision of electric gong signals, watchmen, "Railroad Crossing" signs, etc., at certain specific crossing locations.

Section 2180 of the Code requires any railroad company, incorporated under Delaware laws, to maintain a safety gate or flagman at any crossing within a city or incorporated town, when notified to do so by the city or town authorities.

Related safety devices:

No laws or regulations.

Reflecting devices as a substitute for oil or electric lights:

No laws or rules in effect.

Participation in Federal aid highway grade crossing funds:

Where the State desires to provide and have installed automatic highway grade crossing protection, Delaware participates in Federal fund allotments, allocated to the State under provisions of the "Federal-Aid Highway Act of 1944," approved December 20, 1944, and reimburses the railroads for such projects. The amount of reimbursement is established by agreement covering the individual installation.

Florida.

There is no regulation of installation, maintenance or inspection of railway signaling conferred by State statutes.

Florida participates in the Federal allotment for highway crossings and reimburses the railroads for such projects.

Florida—Continued.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

Georgia.

There is no regulation of installation, maintenance or inspection of railway signaling conferred by State statutes.

Georgia participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

Idaho.

According to I.C.A. 1932, Sec. 59-515, safety regulations—"The Public Utilities Commission of Idaho shall have the power, after a hearing had upon its own motion or upon complaint, by general or special orders, or regulations, or otherwise, to require every public utility to maintain and operate its line, plant, system, equipment, apparatus, tracks and premises in such manner as to promote and safeguard the health and safety of its employees, passengers, customers and the public, and to this end to prescribe, among other things, the installation, use, maintenance and operation of appropriate safety or other devices or appliances, including interlocking and other protective devices at grade crossings or junction and block or other systems of signaling, to establish uniform or other standards of equipment, and to require the performance of any other act which the health or safety of its employees, passengers, customers, or the public may demand."

Upon complaint signed by any taxpayer and also signed by any county commissioner, Commission may hold a hearing and require protection of highway crossing by gates, flagmen, or electric signal or other suitable device (I.C.A. Sec. 59-516).

Idaho participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

Illinois.

Automatic train control:

No State laws.

Signals and interlocking:

Ch. 111 2/3 No. 61 (). The Illinois Commerce Commission are granted the power to regulate public utilities and can require railroad to install, maintain and operate interlockings, automatic signals and other safety devices.

No. 62 () provides that no railroad track may be constructed across the track of another railroad at grade without approval of Commission who shall have the power to prescribe the manner, including the particular point of crossing, and the terms of installation, operation, maintenance, use and protection for each grade crossing.

Ch. 114 No. 68 (Supp.) (1943) requires the railroads to submit plans of proposed interlockings for railroad crossings at grade to the Commission for approval. Also may order discontinuance of any interlocking which it declares unsafe.

Illinois—Continued:

No. 69 (1943). Commission may appoint engineers to examine plans of interlockings and assess cost against railroad.

No. 133 (1943) provides that where two or more railroads cross at grade, one railroad may petition Commission to order such crossing protected by interlocking. Commission may, on its own motion, order railroads to protect grade crossings, where hearing determines that public safety requires it. If railroads cannot agree, the Commission may specify type of interlocking and proportion of expense of installation, maintenance and operation among the various railroads involved.

General Order 6, issued by Illinois Commerce Commission, effective January 1, 1914, prescribes Rules governing the Construction, Maintenance and Operation of Interlocking Plants.

Highway grade crossing protection:

Ch. 111 2/3 No. 62 () provides that no public road, highway or street shall be constructed across any railroad at grade, nor any railroad across a public road, highway or street, without approval of the Commission who shall have the power to prescribe the manner, including the particular point of crossing, and the terms of installation, operation, maintenance, use and protection of each grade crossing.

Also provides the Commission shall have authority to designate grade crossings which are extra hazardous and at such grade crossings shall have the power to require protective devices and also to determine the division of expense for such protective devices between the railroad and the State or its political subdivisions.

Ch. 114 No. 58 () requires that railroads install and maintain crossing signs at all highway-railroad grade crossings, not within corporate limits of cities, towns or villages. Within corporate limits, authorities of cities, towns or villages shall have jurisdiction.

The Illinois Commerce Commission issued General Order 138, adopted July 20, 1937, "Rules, Regulations and Requirements relating to the Construction, Maintenance, Marking and Protection of Crossings of Highways and Railroads in State of Illinois."

The Commission, as of March 30, 1941, supplemented General Order No. 138 with "Specifications for Railroad Highway Grade Crossing Protection."

Related safety devices:

No State laws.

Reflecting devices as a substitute for oil or electric lights:

No State laws.

Participation in Federal aid highway grade crossing funds:

Participate in Federal aid funds.

Railroad pays 10 per cent of cost within estimate, but all in excess of estimate.

The Illinois Commerce Commission issued General Order 22 (as amended), Rules prescribing minimum clearances for structures adjacent to railroad tracks, effective November 1, 1920.

Illinois Commerce Commission issued General Order 160, effective May 1,

Illinois—Continued:

1947—Rules for construction of electrical power and communication lines which contains rules relating to lines adjacent and crossing railroads.

Indiana.

Automatic train control:

No State laws.

Signals and interlocking:

55-101 (q) provides that The Public Service Commission shall have power to require railroads to install, maintain and operate an approved interlocking and derauling device at railroad crossings, swing or drawbridges.

55-101 (r) provides that the Commission may order any interlocking discontinued if it determines that life and property will be best secured thereby.

55-101 (s) provides that the Commission, upon application by railroads, authorize substitution of devices for those which previously have been required.

55-626 provides that with an approved system of interlocking trains may operate over railroad crossings and drawbridges without stopping.

55-1254 provides that after January, 1912, it shall be unlawful for a railroad to operate a train or car over its line that is not equipped and in operation with an automatic block system or other system approved by Railroad Commission of Indiana. Time may be extended by Commission.

55-1255 provides that the Commission may extend the time as specified in 55-1254 when a reasonable necessity exists. Commission may relieve any railroad of this requirement if the volume of traffic, or train or car movement is such that it can be handled without substantial hazard to life or property. Commission may require other systems such as controlled manual block, or manual block, or other form of block, or other signaling systems.

The Public Service Commission of Indiana, under Act of State Legislature issued as of February 1, 1915, prescribed rules and regulations for the installation and maintenance of interlockings. At a session of the Commission, Case 15785, approved February 19, 1943, the rules and regulations contained in this Act were rescinded and the Commission adopted the rules and regulations issued by the Interstate Commerce Commission under the Signal Inspection Act. The Commission requires copies of applications to the I.C.C., copy of the Notice of Approval by the I.C.C., also Notification of the Completion of the Project; the Commission retaining power to make periodic inspections of all interlockings within its jurisdiction.

Highway grade crossing protection:

Chapter 49 (1915). The Public Service Commission of Indiana has the power under the Act of the State Legislature to require protection for highways at crossings with railroads and also the power to condemn and remove obstructions to the view of such crossings.

Sec. 55-2012 (1931) (Amended). Commission, upon proper petition and hearing, may declare railroad-highway grade crossing extra hazardous, requiring additional protection for highway users.

Sec. 55-2014 (1931) (Amended). The installation of additional protection at grade crossings declared extra hazardous shall be paid for as follows: (1) If installed in city or town having more than 700 population (last U. S. census) the cost shall be divided equally between city or town and the railroad. (2) If

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Indiana—Continued:

installed in city or town having less than 700 population (last U. S. census) the cost shall be divided equally between railroad and State Highway Commission.

Sec. 55-2015 (1931) (Amended). After installation of safety devices maintenance costs shall be borne by railroad, except that costs of repairs and renewals shall be divided in accordance with original installation.

Sec. 55-2020 provides common councils of cities of Indiana shall have power to require railroads to keep and maintain lights, as specified by council, at all intersections of streets and railroads.

Related safety devices:

Sec. 55-1248 requires each switch connected with main track to be equipped with a switch light attached to and operated by movement of switch. Light to be left burning constantly between hours of sunset and sunrise and when dark and foggy.

Sec. 55-1249 requires each derail, except when interlocked, to be provided with a switch light attached to and operated by movement of derail. Light shall be kept burning constantly between hours of sunset and sunrise and when dark and foggy.

Reflecting devices as substitute for oil or electric lights:

No State laws.

Participation in Federal aid highway grade crossing funds:

Participate in Federal aid funds.

Railroad pays 10 per cent of cost within estimate, but all in excess of estimate.

Laws and regulations governing clearance of fixed structures adjacent to railroad tracks:

In effect prescribing clearance of structures adjacent to railroad tracks.

Kansas.

Sections 66-162 and 66-163 GS provide the procedure by which when two or more railroads cross at common grade, interlocking devices, automatic signals, or other works or fixtures rendering it safe for engines or trains to pass over the crossing without stopping, may be required and installed under supervision of the State Commission.

Section 68-414 GS provides that when the State Highway Commission deems it advisable, said railroad company may be required by order of the State Highway Commission to install and maintain suitable safety devices or warning signals at dangerous or obscure crossings to indicate the approach of trains.

Kansas participates in the Federal allotments for highway crossings and reimburses the railroads for such projects.

There is no regulation of installation, maintenance or inspection of automatic train control conferred by State statutes.

Kentucky.

Section 277.180 of the Kentucky Statutes provides that whenever railroad lines cross each other in this State each train shall be brought to a full stop at least 50 feet before it reaches the crossing, unless the crossing is regulated by a

Kentucky—Continued:

derailing switch or other safety appliance that prevents collision at crossings, or a flagman or watchman is stationed at the crossing and signals that the train may cross in safety.

Section 277.160 requires that railroads shall erect and maintain at every public highway crossing signs bearing the words "Railroad Crossing." Such signs need not be erected within cities unless required by local ordinances.

Section 277.170 empowers the Railroad Commission to require a railroad to provide gates or flagmen at crossings which the Commission considers to be particularly dangerous. The type of protection and the hours of operation may be specified by the Commission.

In addition to the above, municipalities of the first, second, third and fourth class are given the power by statute to prescribe the character of protection which shall be provided at grade crossings within their boundaries.

Furthermore, where a crossing is unusually dangerous, Kentucky courts hold that it is the duty of railroad companies to provide such additional warnings as are reasonably necessary to give notice of the approach of trains.

Kentucky participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

Louisiana.

There is no regulation of installation, maintenance or inspection of railway signaling conferred by State statutes.

Louisiana participates in the Federal allotments for highway crossings and reimburses the railroads for such projects.

Louisiana Public Service Commission No. 100, adopted by Order No. 1697 on March 24, 1914, as follows:

All railroads in the State of Louisiana, where night trains are scheduled, are required to maintain and keep lighted during the hours between sunset and sunrise, switch lights on all main track, yard and terminal switches, and at such other points as may be deemed reasonable and necessary.

Maine.

Chapter 42, Sec. 85, Revised Statutes of Maine, provides that the Public Utilities Commission may, after due notice and hearing, authorize an interlocking at railroad grade crossings. When such interlocking is installed and approved, trains shall not be required to stop and protect their movements over the crossing.

Chapter 42, Sec. 88, Revised Statutes of Maine, provides that the Public Utilities Commission may, after reasonable notice and hearing, require a railroad to provide automatic signals, gates, flagmen, or other protection at such crossings as required in the interest of public safety.

Maine participates in the Federal allotments for highway crossings and reimburses the railroads for such projects.

Railroads having express trains running after dark required to provide switch lights unless relieved of this requirement by Public Utility Commission.

State furnishes and installs advance warning signs not less than 300 feet from crossing.

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Maryland.

Automatic train control:

No State laws or regulations.

Signals and interlocking:

Permits crossing of tracks of one railroad by tracks of another railroad, either by agreement or condemnation of easement, provided that the crossing road shall, at its own expense, "erect a proper signal station *** and keep a watchman thereat."

Article 23, Sec. 245, 1939 Annotated Code of Maryland State Laws. (First issue Ann. Code 1886, Ch. 107.)

Other than the foregoing there are no State, or Public Service Commission rules or regulations in Maryland governing the nature of protection, such as signals, derails, stops, etc., at railroad grade crossings.

Practice is generally in accordance with Interstate Commerce Commission Rules, Standards and Instructions, effective September 1, 1939.

Highway grade crossing protection:

Whenever a railroad crosses any public highway at grade outside corporate limits of cities, and such crossing shall be believed to be dangerous, it is the duty of the county commissioners, after notifying the railroad, to consider the necessity for protection, and if necessary they may order the railroad to install within sixty days, a flagman, a system of electric alarm bells, or safety gates which shall be closed not less than one-half minute before the passage and during the passage of every railroad train or locomotive across said highway.

Article 23, Sec. 242, 1939 Annotated Code of Maryland State Laws. (First issue Ann. Code 1886, Ch. 294, Sec. 1.)

A.A.R. standard flashing light signals have been installed with approval of the County Commissioners.

Related safety devices:

No laws or regulations.

Reflecting devices as a substitute for oil or electric lights:

No laws or rules in effect.

Participation in Federal aid highway grade crossing funds:

Maryland participates in Federal funds allocated to the State under provisions of the "Federal-Aid Highway Act of 1944," approved December 20, 1944, and reimburses the railroads for such projects. The amount of reimbursement is established by agreement covering the individual installation, as between the railroad and the State Roads Commission, by authority of Sec. 32A of Article 89B of the Maryland Code (Amended by Chapter 560 of the Laws of Maryland, 1947).

Michigan.

Automatic train control:

No State law or regulations.

Signals and interlocking:

No specific regulations covering installation and maintenance.

Michigan—Continued:

Details for signal and interlocking installations at crossings at grade, junctions, and drawbridges may be prescribed if deemed advisable. Plans must be submitted for approval. Costs can be apportioned by Commission on an equitable basis among the companies involved. Sec. 36, Act 300, 1909, p. 704, Eff. Sept. 1, 1909. See also Sec. 11052, page 3882, Compiled Laws of 1929.

A signal light must be maintained from sunset to sunrise on each switch connected with the railroad's main track, and on each derail switch and device, except upon derails connected with the home signal at interlockers or derailing devices on tracks used exclusively for private purposes. Unless ordered by the Commission, requirements do not apply to tracks used for private purposes, to short lines of 100 miles or under, to spurs, or to side lines or railroads on which night trains are not operated. Sections 1 and 2, Act 189, 1921, page 375, Eff. August 18, 1921. See also Sections 11426 and 11427, page 4064, Compiled Laws of 1929.

The Commission may prescribe safeguards at grade crossings of railroad or street railway tracks with other railroad or street railway tracks and may apportion installation cost and any other expense incident thereto between the railroads or street railways affected. Sections 3 and 5, Act 171, 1893, page 270, Eff. August 28, 1893. See also Sections 11416 and 11418, page 4061, Compiled Laws of 1929. As applicable to railroads incorporated in Michigan under Act 198, 1873, page 496, Eff. May 1, 1873, see Section 7 of Article II thereof. See also Section 11119, page 3910, Compiled Laws of 1929.

Requires every locomotive, engine, passenger, freight and other trains to stop not nearer than 200 feet, or farther than 800 feet, from any railroad crossing which is not protected by an interlocking switch and signal system approved by the Commission for operation without stoppage. Sec. 14, Act 174, 1883, Eff. Sept. 8, 1883. See also Section 11182, page 3954, Compiled Laws of 1929.

Practice is generally in accordance with Interstate Commerce Commission Rules, Standards and Instructions, effective Sept. 1, 1939.

Highway grade crossing protection:

Reflector type crossbucks with Number of Tracks signs must be provided by highway authorities on all country crossings and on all State trunk and county highway crossings in cities and villages, with initial expense to be shared equally with railroad and subsequent expense to be borne solely by highway authorities. Section 5, Act 270, 1921, page 501, Eff. May 18, 1921, as amended by Act 336, 1931, page 801, Eff. September 18, 1931. See also Section 11406, page 1161, 1940, Supplement to Compiled Laws of 1929.

Commission may prescribe flashing light signals at railroad crossings, with gong at each signal, with reflector type crossbucks. Number of Tracks signs, and Stop on Red Signal signs, under statutory specifications. Commission may require a minimum of twenty seconds and a maximum of sixty seconds operating, in advance of train movements reaching the crossing. Installation, alteration or relocation cost is borne equally by railroad and highway authorities, but railroad must maintain at its expense, except that highway authorities pay \$10. per month to railroad for each such protected crossing. Voluntary installations are at expense of the railroad. Section 8, Act 270, 1921, page 501, Eff. May 18, 1931, as amended by Section 336, 1931, page 801, Eff. September 18, 1931. See also Section 11409, page 1161, 1940 Supplement to Compiled Laws of 1929.

Michigan—Continued:

In order to forego the \$10. monthly payment, by contract the installation is frequently made at the sole expense of the highway authorities, the railroad assuming the \$10. monthly payment for maintenance.

Where an intersection of highways and railroad requires four flashers instead of the normal two, the Highway Department should pay \$20. to the railroad instead of \$10. Opinion of Attorney General, January 9, 1932, Footnote to Section 11409, 1940 Supplement to Compiled Laws of 1929.

Commission may require railroad to construct and maintain short-arm gate or gates, or maintain a flagman at every highway or street crossing, expense of which is shared equally by the railroads affected. Sections 2 and 4, Act 198, 1873, page 496, Eff. May 1, 1873. See also Sections 11170 and 11172, page 3949, Compiled Laws of 1929. CAVEAT: (Possibly repealed by implication in Section 336, 1931, above).

In case of failure of mechanical or electrical signal protection at highway crossings of railroads, the company operating the railroad, shall, as soon as possible, station a crossing watchman to warn highway traffic until such signals are restored to working order.

Commission will from time to time issue approved plans and specifications as conditions may require with respect to construction of highway crossing signals.

Michigan Public Service Commission Administrative Code, Rule No. 3, Rules and Regulations in Michigan, issued by order of the Commission effective Jan. 1, 1944.

Related safety devices:

Highway authorities at their own expense furnish, renew and maintain, not less than 250 feet nor more than 350 feet from nearest rail advance warning signs as prescribed by the State Highway Commission. Sec. 3, Act 336, Eff. Sept. 18, 1931. See also Sec. 11404, 1940 Supplement to Compiled Laws of 1929.

Highway authorities may construct, install, operate and maintain at any railroad crossing automatic or mechanically operated barricading devices which, when giving warning, shall rise from a bed in the highway and become a barrier in such highway, subject to approval of Commission. Highway authorities to bear expense, unless railroad agrees otherwise in writing. Act 295, 1937, page 550, Eff. Oct. 29, 1937. See also Section 4631-1, et. seq., page 454, 1940 Supplement to Compiled Laws of 1929.

Reflecting devices as a substitute for oil or electric lights:

Reflecting devices are not permitted for the purpose stated. See "Signals and Interlocking," paragraph relating to lights on switch and derail lamps. Sec. 1, Act 189, 1921, p. 375, Eff. Aug. 18, 1921. There is nothing in the statutes or regulations to prevent the use of reflecting devices where such devices are not substituted for the required oil or electric lamps.

Participation in Federal aid highway grade crossing funds:

Michigan participates in Federal allotments for highway crossings under provisions of the Federal-Aid Highway Act, and reimburses the railroads for such projects. The State of Michigan by Act 99, 1917, page 178, Eff. April 25, 1917. (See also Sec. 4398, page 1736, Compiled Laws of 1929) accepted the provisions of the "Federal Aid Act" approved July 11, 1916, of which the "Federal-Aid Highway Act of 1944," approved Dec. 20, 1944, is an amendment.

Minnesota.

Automatic train control:

No State laws or regulations.

Signals and interlocking:

219.93 (1866) provides that trains or engines must come to a full stop not less than 165 feet nor more than 990 feet from railroad crossings or junctions before proceeding unless an interlocking approved by the Commission is provided.

169.073 (1943) provides that red lights or signs shall not be maintained in the vicinity of a railroad if their indication is such as to interfere with efficiency or effectiveness of signals or devices used in operation of the railroad.

Other State statutes and rules and regulations of the Minnesota Railroad and Warehouse Commission applying to interlocking and automatic block signaling are no longer effective as the jurisdiction has been assumed by the Interstate Commerce Commission, effective August 26, 1937.

Highway crossing protection:

219.14 (1919) provides that the Minnesota Railroad and Warehouse Commission may on its own motion investigate any railroad-highway crossing and may, after hearing order it protected "in any manner it may find reasonable and proper."

219.24 (1925) provides that the Commission may, after notice and hearing in which it finds that conditions exist which require additional safeguards at railroad highway crossings, specify the nature of the devices required and order the railroad company to install.

219.39 (1911) provides that upon complaint of village, city, town, or county that a railroad-highway crossing is dangerous, the Commission shall investigate and hold a hearing.

219.40 (1911) provides that following such investigation and hearing as prescribed in 219.39, the Commission "may require the railroad company *** to adopt such safety device as the Commission may deem necessary for the proper protection of the crossing ***"

219.26 (1925) provides that the Commission shall secure uniformity in the devices used to protect railroad-highway crossings. Such devices shall be approved by the Commission before installation.

Rules and specifications pertaining to signs and signals for use at railroad-highway grade crossings were adopted July 15, 1936.

Principal requirements:

- (a) Electric highway crossing signals shall be of the flashing light type with rotating stop discs, standard drawing provided.
- (b) Installation of signals must be approved by the Commission.
- (c) Detailed specifications are generally similar to Bulletin No. 3 of the Joint Committee on Grade Crossing Protection, A.A.R.
- (d) All tracks over crossings shall be provided with track circuits.
- (e) Signals shall display most restrictive indication as long as any part of the crossing is occupied.
- (f) Bells may be used in conjunction with signals.

See "Rules and Regulations of the Minnesota Railroad and Warehouse

Minnesota—Continued:

Commission" affecting Highway-Railroad Grade Crossings.

The Commission is currently developing specifications covering automatic gates.

Related safety devices:

219.19 (1925) provides that railroad companies shall furnish advance warning signs for use at crossings specified by the Commission and the same shall be erected and maintained by the local public authorities responsible for the street or highway in question.

Reflecting devices as a substitute for oil or electric lights:

No statutes or Commission rules or orders pertaining to switch lamps.

Participation in Federal aid highway grade crossing funds:

At crossings protected under the various Federal Aid Programs, flashing light type signals with rotating stop discs have been used exclusively. Heretofore installations have been handled by contract to the lowest bidder, with railroad company performing any track work or alteration of existing facilities.

Mississippi.

There is no specific regulation of installation, maintenance or inspection of railway signaling conferred by State statutes. The practice is generally in accordance with I.C.C. Rules.

Section 7857 provides that whenever the Public Service Commission shall declare the safety of the public to require, and shall so order, the railroad whose track crosses a thoroughfare must maintain a gate at the crossing thereof. The Commission may prescribe the material, dimensions and mode of operation of such gates.

Section 8039 gives the State Highway Commission exclusive jurisdiction and control of grade crossings and warning devices upon the State highway system.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

Mississippi participates in Federal allotments for highway crossings and reimburses railroads for such projects.

Missouri.

Section 5627 provides the Public Service Commission with exclusive power to determine and prescribe the manner, including the particular point of crossing, and the terms of installation, operation, maintenance, apportionment of expenses, use and protection of each crossing of one railroad by another railroad or street railroad, and of a street railroad by a railroad, and of each crossing of a public road or highway by a railroad or street railroad and of a street by a railroad or *vice versa*, so far as applicable, and to alter or abolish any such crossing, and to require, where, in its judgment, it would be practicable, a separation of grades at any such crossing heretofore or hereafter established, and to prescribe the terms upon which such separation shall be made and the proportion in which the expense of the alteration or abolition of such crossings or the separation of such grades shall be divided between the railroad or street railroad corporations affected or between such corporations and the State,

Missouri—Continued:

county, municipality or other public authority in interest: *Provided*, however, that in all cases of the State highways, not more than one-half of the cost of construction of any grade separation, overhead or underpass, authorized or ordered by the Commission shall be apportioned to the State Highway Commission.

Section 5695 provides the Commission with power to prescribe the installation, maintenance and operation of appropriate safety devices including interlocking, block signaling and other systems of signaling.

General Order No. 10 provides that no changes shall be made in the locking or in the location of any unit in an interlocking plant until plans have first been submitted to and approved by the Commission. It requires that plans for the construction of an interlocking plant shall be submitted to the Commission for approval and outlines the procedure to follow.

This order also provides that reports for each interlocking plant shall be filed with the Commission in the manner and form prescribed by it. These reports describing the general condition of the interlocking, as well as all failures, if any, in the preceding period, must be kept for each quarter and filed with the Commission.

Case No. 8308, Supplemental Order No. 3, requires the use of highway crossing signals in accordance with Bulletin 3 of the Joint Committee on Grade Crossing Protection, A.A.R., pages 3 to 19, inclusive, issued October 1942, unless specifically excused by order of the Commission. Also plans for highway crossing protection must be submitted to the Commission for approval prior to installation.

Section 5282 (1939) requires lights between sunset and sunrise on main track switches and on lead switches in yards.

Missouri participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

Montana.

There is no regulation of installation, maintenance or inspection of railway signaling conferred by State statutes.

The Board of Railroad Commissioners of Montana may order the installation of an electrically operated bell or other signaling device upon petition of any board of county commissioners when the contour of the country adjacent to the crossing is such that a person approaching it along a highway cannot, at a distance of 25 feet from the crossing, obtain an unobstructed view of the railroad track for a distance of one-half mile on either side of the crossing (R.C.M. 1935 Sec. 3842).

Montana participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

New Hampshire.

Chapter 299, Section 35 of the Revised Laws of New Hampshire authorizes the Public Service Commission to require a railroad to provide gates, automatic signals, flagmen, or to clear adjacent land of obstructions when in the opinion of the Commission public safety demands that the crossing be so improved. The cost incurred shall be divided between the railroad, town or state in such proportion as the Commission may determine to be equitable.

New Hampshire—Continued:

New Hampshire participates in the Federal Aid program for highway crossings and reimburses the railroads for the cost of approved projects.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

Order No. 3358 (Oct. 15, 1937) issued by the Public Service Commission requires railroads to install highway advance warning signs and the municipalities to thereafter maintain them.

*New Jersey.**Automatic train control:*

No specific State law or regulations. The type of protection is at the discretion of the Board of Public Utilities Commissioners.

Signals and interlocking:

There are no specific regulations covering the installation or maintenance of signals and interlocking. The statutes provide that installations shall be "safe, adequate, and proper," and delegate to the Board of Public Utilities Commissioners the authority to require the carriers to comply.

When changes and new installations are made, copies of the applications to the Interstate Commerce Commission are desired by the Board of Public Utilities Commissioners to insure compliance with the statutes. Practice in accord with the Interstate Commerce Commission Rules, Standards and Instructions is generally acceptable.

Highway grade crossing protection:

The type of protection is at the discretion of the Board of Public Utilities Commissioners. Installations of automatic highway crossing protection shall in general conform with the recommendations of the A.A.R., except in respect to automatic crossing gates the Board has established a minimum warning period of 30 seconds before the arrival of the fastest train at the crossing.

No carrier shall, without the approval of the Board of Public Utilities Commissioners, make any change in the form of protection.

In connection with the installation of short arm automatic crossing gates, a warning bell is generally required as a part of the installation, the bell to keep ringing until the gates have reached the horizontal position, and then stop.

Related safety devices:

Railroads are required to furnish, install and maintain reflex advance warning signs at highway grade crossings even though not located on the railroad right-of-way. The use of "No Right Turn" and "No Left Turn" signs is very favorably regarded by the Board.

Reflecting devices as a substitute for oil or electric lights:

Reflecting devices such as reflectorized switch lamps, targets, signs, etc. are not covered specifically by legislation, but are subject to regulation by the Board of Public Utilities Commissioners.

Participation in Federal aid highway grade crossing funds:

The State of New Jersey participates in Federal fund allotments and the amount of reimbursement to the railroad is as agreed upon for each individual installation.

New Mexico.

There is no regulation of installation, maintenance or inspection of railway signaling conferred by State statutes.

Chapter 74 of the New Mexico Statutes 1941 Annotated gives the requirements for highway grade crossing protection.

New Mexico participates in the Federal allotments for highway crossings and reimburses the railroads for such projects.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

New York.

Signals and interlocking:

No specific regulations covering installations and maintenance. Under the provisions of the railroad law, 1947, Section 56, all trains and locomotives on railroads crossing each other at grade shall come to a full stop before crossing, and shall cross only when the way is clear and upon a signal from a watchman stationed at the crossing. The full stop may be discontinued if the Commission shall decide it to be impracticable or if, with the approval of the Commission, interlocking switch and signal apparatus is adopted and put in operation at such a crossing. The Commission may, whenever in its judgment public safety requires the erection of interlocking switch and signal apparatus, direct the erection of such devices.

The Public Service Commission has the power to determine if facilities are safe and adequate and to enter and inspect railroad facilities to determine if safe and adequate, with proper regulations, practices, equipment and appliances, and service in effect.

Approval of the Commission not required for interlocking changes.

Order of the Commission, dated May 28, 1946, Case No. 11660, requires that derailing devices should be installed at all sidings connected with main tracks, "except (a) at sidings connecting the main tracks within interlocking limits or where the movement from the siding to the main track is controlled by signal indication, (b) at sidings at locations where the attained maximum speed of scheduled passenger trains is not in excess of 30 miles per hour; and (c) at sidings having a grade of 0.35 per cent or more descending away from the main track upon which sidings operations are performed, except in emergency, only when the main track is occupied by a part of the train which does the switching service or where the main track switch protected by signal is kept reversed while the train is clear of the main track, and (d) on sidings which are not used, except in emergency, for clearing trains in territory where passenger trains are not permitted to enter a block until all other trains are clear of the main track." This order further provides:

That the connection of derails with the signal system shall be in such a manner that when a derail is set for movement to or from a siding the signals protecting the main track movements in the vicinity will indicate that the derail is in non-derailing position, or in lieu of such connection with the signal system and in non-signalled territory derails shall be so connected with their main track switches that the derail may not be set for a movement from the siding until after or simultaneously with the operation of the switch for such movements.

New York—Continued:

The Order provides for appeal where the installation is claimed to be impracticable, unwarranted, undesirable or a hazard.

Highway grade crossing protection:

Installation of automatic grade crossing protection in general conforms with the recommendations of the A.A.R. The use of short arm crossing gates has been approved by the Commission.

Plans for installations and changes must be submitted to the Commission for approval.

In connection with highway grade crossing protection in Case 10723, Order of the Commission, dated September 10, 1943, required the following additional protection:

1. Annunciators at all crossings with or without gates where watchmen are provided.
2. Electric lamps on all gates.
3. Where gates are in service and not continuously attended, install reflector signs "Gates Not Working."
4. Automatic flashing light signals at crossings protected by watchmen without gates.

Appeal for relief from the above requirements may be made if physical, operating or other conditions make it impossible or impractical to install or maintain the protection directed.

North Carolina.

N.C. Code 1943, Sec. 62-49, empowers the North Carolina Utilities Commission to require a railroad to provide a block system or other safety device on any part of a railroad on which eight or more trains are operated each way daily.

N.C. Code 1943, Sec. 62-51, empowers the Commission to require the installation of interlockings at railroad crossings and drawbridges when the public safety demands such protection.

The State Highway Commission is authorized (Sec. 136-20) to require the construction of an overpass or underpass at dangerous crossings or to require the installation of gates or other safety devices at grade crossings, one-half of the cost of installation to be borne by the Commission and one-half by the railroad. The Commission will bear no part of the maintenance costs except in the maintenance of an overpass.

North Carolina participates in Federal allotments for highway crossings and reimburses the railroads for such projects, with the exception that the State and railroads each bear 50 per cent of the cost of surveys, plans, specifications and estimates.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

North Dakota.

By statute, it is the duty of the railroads to provide such service and equipment as shall promote the safety and convenience of its employees and the public. (N.D.R.C., 1943, Sec. 49-0401.)

The Public Service Commission of North Dakota may, after hearing,

North Dakota—Continued:

prescribe by its order, rule or regulation for proper service or equipment (Sec. 49-0204). Subject not specifically included.

The Commission may, upon written complaint by State Highway Commission, any board of county commissioners, any board of supervisors of a township, any officer, board, or agency having jurisdiction over public highways, or upon its own motion, order any railroad grade crossing protected in any manner it may find reasonable and proper. (N.D.R.C. 1943, Secs. 24-0908 and 49-1113.) No devices used to protect grade crossings shall be installed until the same have been approved by the Commission (Sec. 24-0909).

North Dakota participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

Ohio.

Automatic train control:

No State laws.

Signals and interlocking:

Sec. 8826 (1882) requires that where the tracks of two railroads cross each other or in any way connect at common grade, a watchman shall be maintained at joint expense of railroads. All trains or engines must come to a full stop not nearer than 200 feet, nor farther than 800 feet from crossing and not cross until signaled to do so by watchman, nor until way is clear.

Sec. 592 (1896) provides that if an interlocking is installed at grade crossings or drawbridges and if approved by the Commission train or engines may operate over crossing or drawbridge without stopping.

Sec. 594 (1908) provides that Commission may order railroads, crossing at grade, to install interlocking to protect the crossing, if in its opinion public safety requires such protection.

July 1, 1914—The Commission issued rules governing the installation and operation of interlockings at railroad crossings and drawbridges.

Sec. 614-3 (1929). The Public Utilities Commission of Ohio is vested with the power and jurisdiction to supervise and regulate railroads in respect to the protection, welfare and safety of railroad employees and the traveling public.

Highway grade crossing protection:

Sec. 588 (1890) provides that the Commission, if public safety requires, may require that grade crossings of highway and railroads be protected by gates, watchmen, or automatic protection at the expense of the railroad provided that the Commission have declared the crossing as dangerous.

Sec. 590 (1894) prescribes the manner of providing highway protection required by the Commission.

Sec. 591 (Amended) prohibits the abandonment of highway gates or watchman or substitution of automatic protection therefor. (Relief from this section may be obtained from Commission.)

If a crossing within a municipality is considered dangerous and a traffic hazard has been established, authorities of the municipality having jurisdiction may construct, purchase and operate a safety device and the cost thereof shall be borne by the municipality.

Sec. 591-1 (1927) provides that the municipality shall place a warning sign

Ohio—Continued:

not less than 200 feet from a safety device installed in a street for protection of traveling public.

Related safety devices:

No State laws.

Reflecting devices as a substitute for oil or electric lights:

No State laws.

Participation in Federal aid highway grade crossing funds:

Participate in Federal aid funds.

Railroad pays 10 per cent of cost within estimate, but all in excess of estimate.

Sec. 8975 (1921) requires the Commission to determine standards of maintenance and operation and also the nature, location and character of construction of telegraph, telephone, electric light, power, or other electric wires across or parallel railroads. Administrative Order No. 72, approved October 1, 1946 was issued by the Commission.

Sec. 8976-1 (1927) specifies clearances for all structures and material contiguous to railroad tracks, viz.: not less than 8 feet in clear from center of track, not less than 21 feet from top of rail. The Commission may grant permission to infringe these clearances.

Oklahoma.

There is no regulation of installation, maintenance or inspection of automatic train control or signals conferred by State statutes.

Sec. 27, Article IX, provides that in case any railroad company shall seek to cross at grade the track or tracks of another railroad, the railroad seeking to cross at grade, within a reasonable time, shall be compelled to interlock or protect such crossings by safety devices to be designated by the Corporation Commission of Oklahoma and all cost of appliances, together with expense of putting them in, shall be borne equally by each company, provided that this act shall not apply to crossings of side tracks.

Highway grade crossing protection:

Title 17, Sec. 82, gives the Corporation Commission exclusive jurisdiction to determine and prescribe the location and type of protection required.

Title 17, Sec. 82 (1941), provides that the expense of construction and maintenance of public highway grade crossings shall be borne by the railroad involved; also provides in case of overgrade or undergrade crossings assignment of cost and maintenance shall be left to the discretion of the Corporation Commission; but in no event shall the city, town or municipality be assessed more than 50 per cent of the actual cost.

Title 66, Section 125 (a), provides for public authorities having jurisdiction of public highways or streets to require railroads to install and thereafter maintain and operate an automatic or mechanically operated barricade device. The detailed plans of such devices with the description of proposed mode of operation and map showing the proposed location, must be first submitted to and approved by the State Highway Commission.

Oklahoma—Continued:

Title 66, Section 125 (b), provides for reflector warning signs to be installed where the barricades provided for in Section 125 (a) are installed; said warning signs to be installed not less than 400 feet from the crossing where highway speed in excess of 30 miles per hour is permitted, and not less than 200 feet from the crossing when highway speed not in excess of 30 miles per hour is permitted.

There are no statutes prescribing the type of highway crossing protection devices to be used but the Corporation Commission customarily desires the flasher type signals as recommended by A.A.R.

This State participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

Oregon.

Order No. 4057 (Feb. 13, 1937), issued by the Public Utilities Commission, establishes certain requisites for crossing protection in substantial conformity with recommendations of the Joint Committee on Grade Crossing Protection, A.A.R.

House Bill No. 250, passed by the State Legislature and signed by the Governor March 4, 1947, takes away from all cities and towns, except the City of Portland, the power to prescribe maximum speed limits of trains within the municipal boundaries and invests such power in the State. It provides that upon petition of any railroad or of any city or town, the Public Utilities Commissioner, after hearing, shall determine maximum speed limits. It also gives the Public Utilities Commissioner the power to prescribe in the same order in which the speed limits are fixed, the type of crossing protection, if any, which shall be installed, and to divide the cost of such installation and maintenance between the city and railroad in accordance with the benefits derived respectively by each. This bill becomes law 90 days after the adjournment of the present legislative session.

Pennsylvania.

Automatic train control:

No State laws or regulations.

Signals and interlocking:

Railroad Regulations, issued by the Pennsylvania Public Utility Commission in 1946, govern carriers subject to the jurisdiction of the Commission. Installations made in compliance with the Interstate Commerce Commission Rules, Standards and Instructions are acceptable. The State does not generally prescribe the details of signal installations and interlockings. No carrier shall, without Commission approval, remove the protection afforded by interlocking signals or alter any existing form of protection at crossings, at grade, of the tracks of a carrier across the tracks of another carrier.

Highway grade crossing protection:

Railroad Regulations, issued by the Pennsylvania Public Utility Commission in 1946, govern carriers subject to the jurisdiction of the Commission.

Automatic highway grade crossing signals, in general, shall conform to Bulletin No. 3 of the Joint Committee on Grade Crossing Protection, A.A.R.

Pennsylvania—Continued:

The Commission, in cooperation with the railroad, analyzes each individual installation and specifies such modifications as may be found necessary. Prior to installing automatic crossing signals at any unprotected crossing of a public highway, at grade, across its track or tracks, or at such a crossing which is protected by fixed signs only, a carrier shall submit to the Commission plans of such proposed installation and receive approval of such plans.

No carrier shall without Commission approval, remove the protection afforded by crossing gates, watchmen, automatic crossing signals or any other protection against accidents or reduce the number of hours that manual protection is maintained or substitute or alter any existing form of protection at crossings, at grade, of the tracks of a carrier across a public highway.

The Department of Highways may, upon proper application to and approval of the Pennsylvania Public Utilities Commission, participate to the extent of one-half of the actual cost (or such other proportion as agreed to) of installing protection at State highway grade crossings. Similarly, the Commission itself may participate in the cost of installation of such protection at street and highway crossings.

The carriers affected shall install and maintain the signals.

Related safety devices:

If advance warning signs or other similar facilities are installed along the highway leading to the crossing, the cost of such facilities, and work and expense of their installation and maintenance shall be borne and performed in such manner as agreed upon by the parties or as directed by the Commission.

Reflecting devices as a substitute for oil or electric lights:

No laws or rules are in effect, but such devices are subject to regulation by the Commission.

Participation in Federal aid highway grade crossing funds:

In Pennsylvania the Department of Highways handles Federal Aid highway grade crossing funds subject to approval by the Federal authorities. If recommended by that department Federal Aid Highway Funds may be used in paying for a portion or all of the costs of flashing light signal protection at public grade crossings in Pennsylvania.

South Carolina.

S.C. Code 1942, Sec. 8225, gives the South Carolina Public Service Commission power to require the installation of such safety devices as are, in their opinion, necessary or desirable.

South Carolina participates in Federal allotments and reimburses the railroads for such projects, with the exception that the State does not bear any part of the cost of surveys, plans, specifications and estimates.

South Dakota.

Automatic train control:

No State laws or regulations.

Signals and interlocking:

52.0940 (1909) provides that the Public Utilities Commission may require railroads to "install such signal system—or any other device or appliance that in its judgment will best promote the public safety." The Commission may require railroads to install interlocking at railroad crossings, junctions and drawbridges, and determine division of cost between respective companies if necessary.

It is the usual practice to submit general plans covering major changes and additions to interlocking facilities to the Commission for approval. Other plans are not submitted.

On February 14, 1914, the Commission adopted certain rules pertaining to interlocking which are identical to those adopted by Wisconsin.

Highway crossing protection:

28.1101 (1919) provides that upon complaint or upon its own motion, the Commission may, after proper investigation of any railroad-highway grade crossing, prescribe the method of protection required in the interest of public safety.

28.0901 (1919) requires that railroad companies will furnish and install approach warning signs at all highway crossing except within the limits of incorporated villages and cities. Signs to be located not less than 150 feet nor more than 180 feet from the point of crossing.

There are no specific rules relating to highway crossing protection. It is not the practice to submit plans to the Commission for approval.

Related safety devices:

No State laws or regulations.

Reflecting devices as a substitute for oil or electric lights:

52.0936 (1909) requires lighted switch lamps on all main track switches where trains operated at night. In 1943 the statute was amended to permit the use of reflectorized switch lamps "where, on the average, not more than one switching movement occurs between sunset and sunrise."

Participation in Federal aid highway grade crossing funds:

At crossings protected under the various Federal Aid programs, flashing light type signals with rotating stop discs have been used exclusively, but automatic gates are being proposed in some instances for programs now being developed. The State Highway Department submits plans for Federal Aid crossing protection projects to the Public Utilities Commission for approval. Heretofore installations have been handled by contract to the lowest bidder, with the railroad company performing any track work or alteration of existing signal facilities.

Tennessee.

Sections 2634, 2635 and 2637 of Williams Tennessee Code provide that trains must be stopped at railroad crossings unless the crossing is interlocked, and,

Tennessee—Continued:

except when the intersecting roads are under the management of the same company, engines and trains run upon the longer road are not required to stop.

As a result of certain court decisions, municipalities appear to have the power to require railroads to provide crossing protection.

Tennessee participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

Texas.

Articles 6371 (1942 Supplement) and 6502, Texas Statutes, provide that trains must be stopped at railroad grade crossings unless interlockings are provided, and the Railroad Commission is authorized to require and specify such interlockings. In 1927 the Railroad Commission of Texas issued circular No. 7454-A setting forth specifications for interlockings, requiring submission and approval of plans, and requiring inspections and reports.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

The State Highway Department place and maintain the reflectorized signs in approach to railway crossings at grade.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

Utah.

The State Public Service Commission has jurisdiction of automatic train control, signals, interlocking and highway grade crossing protection but up to the present time has exercised its regulatory powers only over grade crossing matters, both railroad and public highway.

Local authorities install and maintain reflectorized signs in approach to railway crossings at grade except on Federal Aid projects. Railroads are required to furnish and install such signs but the expense of same is reimbursable from participating funds, the contract for each individual project specifically mentioning this feature. Also the contract provides that maintenance and repair of such signs is to be the responsibility of either the State, county or city.

Vermont.

The Public Service Commission may (Sec. 6234, Chap. 254, Public Laws of Vermont) require a railroad to provide protection at certain grade crossings and may specify when and how such protection is to be provided.

Vermont participates in the Federal Aid program for highway crossings and reimburses the railroad for cost of approved projects. The railroad pays the full cost of all other installations regardless of authority ordering construction.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

There is no law or rule in effect relating to highway grade crossing advance warning signs.

Virginia.

Chapter 155, Section 3989 gives the State Corporation Commission authority to require any company operating a railroad to establish and maintain the block system or some other equally efficient system to regulate the movement of its trains, in order to prevent collisions.

Chapter 155, Section 3987—WHEN TRAINS SHALL BE STOPPED BEFORE GETTING TO RAILROAD CROSSING—"Whenever railroads cross each other on the same grade in this State, the trains shall be brought to a full stop at least fifty feet before getting to the crossing; but the provisions of this section shall not be applicable where the crossings of such roads are regulated by derailing switches, or other safety appliances, which prevent collision at crossing, nor where a flagman or watchman is stationed, or signal tower is located, and signals that the trains may cross in safety."

Virginia participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

Washington.

By statute, the Department of Transportation of Washington may, after hearing, make an order directing reasonable repairs, additions, or improvements in equipment or facilities to promote security or convenience of the public or employees (RRS Sec. 10400). Subject not specifically included.

By statute, the Department may order a railroad to install and maintain at grade crossings, proper signals, warnings, flagmen, interlocking, devices, or other devices or means to secure the safety of the public and its employees (RRS Sup. Sec. 10513).

The authority of the Department does not extend to the crossings in cities which are authorized to frame their own charter (over 20,000 population) (RRS Sec. 10531). Authority there is vested in the city governmental body.

Washington participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

West Virginia.

West Virginia Code 1943 Sec. 31 Art. 2-8-3104 requires trains to stop at unprotected railroad crossings, provided the railroad crossings are not equipped with fixtures approved by the Public Service Commission.

West Virginia participates in Federal allotments for highway crossings and reimburses the railroads for such projects.

There is no law or rule in effect relating to reflecting devices as a substitute for oil or electric lights.

Wisconsin.

Automatic train control:

No specific State laws or regulations. See Sections 195.26 and 195.03 below.

Signals and interlocking:

192.28 (1872) provides that trains or engines must come to a full stop within 400 feet of railroad crossings and within 600 feet of drawbridges before proceeding unless signaled to proceed by a man on the ground or unless an inter-

Wisconsin—Continued:

locking approved by the Public Service Commission is provided. Does not apply to steam roads at crossings with electric railroads.

195.26 (1911) provides that railroads shall provide reasonable safety devices. Public Service Commission may order railroads to provide block system or other safety devices.

It is the practice to submit detailed plans covering all changes and additions to automatic block signal systems and interlocking facilities to the Commission for approval.

195.03 (p. 18) (1907) provides that Commission shall establish rules and regulations for installation, operation, and maintenance of all safety devices and measures.

Rules pertaining to interlocking were adopted by the Commission October 8, 1913. Principal requirements are as follows:

(a) Plans covering new installations and changes in existing facilities must be submitted to the Commission for approval.

(b) Following completion of new work or major changes, interlockings must be placed in conditional service for not less than 24 hours and until approved by Commission Inspector.

(c) Requisites for interlocking plants are generally less restrictive than those of the Interstate Commerce Commission. Derails are required at crossings, junctions, and drawbridges but this requirement has been generally waived by the Commission in recent years.

(d) Quarterly inspection reports for each interlocking must be filed with the Commission by the maintaining railroad company.

See "Rules governing the construction, maintenance, and operation of interlocking plants" adopted by the Railroad Commission of Wisconsin effective December 1, 1913.

Highway grade crossing protection:

192.29 (1872) provides that trains or engines will not exceed 15 miles per hour within 330 feet of any public crossing in a city or village. If gates or flagmen are provided, speed of trains or engines will not exceed 30 miles per hour within 330 feet of crossing and if electric bell or signal is provided, speed of train or engine will not exceed 20 miles per hour within 330 feet of crossing. Flagmen, gates, or mechanical devices shall be placed at crossings as directed by village or city authorities.

195.28 (1905) provides that upon complaint of village, city, or town that a railroad-highway crossing is dangerous, the Commission may after proper investigation and procedure order the railroad company to provide gates, flagmen, electric signal, or other safety devices if required.

By Order (R 3674) of the Commission dated August 12, 1929, the use of either wig-wag signals or flashing light signals with rotating stop discs is specified for highway crossing protection. Plans must be submitted to the Commission for approval.

In recent years the Commission has approved the use of automatic gates.

Related safety devices:

192.48 (1917) requires railroad companies to furnish advance warning signs for use at railroad-highway crossings outside the limits of incorporated villages

Wisconsin—Continued.

or cities except at crossings with state trunk highway system. Signs are furnished to County Highway Commissioners who are in turn responsible for installation and maintenance. Signs for crossings with state trunk highway system are furnished, installed, and maintained by the State Highway Department except within limits of villages and cities.

Reflecting devices as a substitute for oil or electric lights:

Commission Order (R-3122), dated July 15, 1924, and effective August 24, 1924, requires that all main track switches be equipped with switch lamps, except on trailing point switches in automatic block signal territory and at locations where "the number of trains operating during any period between sunset and sunrise shall be not more than two per week."

Commission Order R-3122 was amended October 17, 1942 to permit use of reflectorized switch lamps after making application to the Commission and receiving informal approval.

Commission Order R-3122 was further amended February 28, 1947 to provide for the Commission issuing public notice of application to install reflectorized switch lamps. If requested within 20 days of such public notice, a hearing will be held, otherwise the application will be disposed of by informal approval.

Participation in Federal aid highway grade crossing funds:

At crossings protected under the various Federal Aid programs, flashing light type signals with rotating stop discs have been used exclusively. Stipulations are entered into by the railroad company and the State Highway Department covering such installations and the approval of the Public Service Commission secured. Installations are made by railroad company forces.

Wyoming.

There is no regulation of installation, maintenance or inspection of railway signaling conferred by State statutes.

Local authorities install and maintain reflectorized signs in approach to railway crossings at grade except on Federal Aid projects; the railroads are required to furnish and install such signs, but the expense of same is reimbursable from participating funds; the contract for each individual project specifically mentions this feature. Also the contract provides that maintenance and repair of such signs, is to be the responsibility of either the State, county or city.

Canada.

All railways, rail level crossings, junctions and movable bridges, as well as protection at highway crossings, are governed by a Federal law known as the "Railway Act" (Statutes of Canada 1919, Chapter 68, and subsequent amendments), and the Provinces have no jurisdiction in such matters. The Act is administered by the Board of Transport Commissioners for Canada, hereinafter referred to as the "Board."

Level crossings and movable bridges:

Section 252 of the Act provides that the tracks of any railway company shall

Canada—Continued:

not cross or join with the tracks of any other company until permission has been obtained from the Board, and that no train shall be operated until the Board authorizes such operation by an Order.

Section 254 provides that the Board may order installation at any such crossing or junction, of an interlocking system as the Board may deem renders it safe for engine and trains to pass over such crossing or junction without being brought to a stop.

Section 305 provides that trains shall be brought to a full stop before crossing over any draw or swing bridge, and shall not proceed until a proper signal has been given, and further provides that where there is an interlocking or other devices in service, the Board may, by Order permit trains to pass over such bridges without stopping, with such regulations as to speed and other matters as the Board may decide.

Sections 306 and 307 provide that trains, engines or electric cars shall not pass over any crossing at rail level of two main lines or branch lines until a proper signal has been received by the train from a watchman in charge of such crossing, and in the case of an electric car, provides that where no watchman is in charge of the crossing, conductor is to proceed to the crossing, and, if way is clear, give proceed signal to motorman.

Section 307 provides that all engines, train or electric cars shall stop before passing over any crossing at rail level, and further provides that where an interlocking or other device is in service, the Board may, by Order, permit trains to pass over such crossings without stopping, with such regulations as to speed and other matters as the Board may decide.

Highway crossings:

Section 256 grants the Board wide powers in respect to highway crossings, and among others provides that it must approve all new crossings and may order watchmen or protection; it may order protection at existing crossings, or order the highway carried over or under the railway.

Section 262 provides for a Fund to aid in the protection or elimination of highway crossings. This Fund is known as the "Railway Grade Crossing Fund" and the Board is limited to appropriating a sum of not more than 40 per cent of the cost of any one crossing, and in no case exceeding \$100,000.00.

Section 309 as amended by Parliament and covered by General Order No. 704 requires that the speed of trains shall not exceed a speed of 25 miles per hour over any highway crossing at which a person or vehicle has been struck by a train, and bodily injury or death results, until such crossing is protected to the satisfaction of the Board.

Section 283 authorizes the Board to inspect any railway or any portion thereof if considered dangerous to the public using the same, from want of renewal or repair or insufficient or erroneous construction, or from any other cause and may order any repairs, renewals, reconstruction, alterations or new work to be made.

General Order No. 547 (amended by General Order No. 572) covers regulations regarding plans to be filed with the Board under Sections 252 and 305 of the Railway Act, also covers general requirements for interlocking appliances.

Canada—Continued:

General Order No. 607 covers specifications for highway crossing signals of the flashing light type.

General Order No. 675 covers specifications for highway crossing signals of the wig-wag type.

General Order No. 676 (amended by General Order No. 680) covers specifications for automatic gates.

Communications for the Board should be addressed: The Secretary, Board of Transport Commissioners for Canada, Ottawa, Ontario, Canada.

Action Recommended

Acceptance as information.

NUMBER AND TYPES OF HIGHWAY CROSSING PROTECTION
INSTALLATIONS IN THE UNITED STATES

The tabulation (Table I), by States and Provinces, of the number and types of highway crossing protection installations in the United States and Canada was compiled from answers received from Signal Section Voting Representatives of Member Roads in response to Inquiry SS-72A issued July 28, 1947. Statistics by railroads have not been compiled as the Committee is of the opinion such information is of no material value and would result in too voluminous a report. If specific information for a railroad shown in the tabulation is desired, it can be secured by addressing Mr. H. D. Abernethy, Chairman of Subcommittee B of Committee III.

Key to headings of Table I is as follows:

- A—Automatic crossing bells
- B—Automatic crossing bells and watchmen
- C—Automatic crossing bells and manual gates
- D—Automatic wig-wag signals
- E—Automatic flashing light signals
- F—Automatic flashing light signals and bells
- G—Automatic flashing light signals and gates
- H—Automatic flashing light signals and manual gates
- J—Automatic flashing light signals and watchmen
- K—Automatic flashing light signals and "No Right"—"No Left" turn
- L—Automatic flashing light signals and rotating banner

Automatic, manual or all manual control installations included in the following five classifications:

- M—Flashing light signals and rotating banner
- N—Flashing light signals only
- O—Flashing light signals and automatic gates
- P—Flashing light signals and bells
- Q—Wig-wag signals

Special protection:

- R—Manually operated traffic lights
- S—Automatically operated traffic lights
- T—Manually operated crossing bells
- U—Miscellaneous devices
- V—Traffic barrier

Action Recommended

Acceptance as information.

TABLE I—Continued

State	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T	U	V
South Carolina.....	2			1	66	51					38		3		7		4	2		1	
South Dakota.....	3			5	53						54	2	3								
Tennessee.....	4			28	186		5						14	9		31		18		8	
Texas.....	76			394	469	15	11						5	36		1	19	28	2	3	
Utah.....	12			82	155																
Vermont.....	10			1	54	24	11								5						1
Virginia.....	14			117	134	34					1		6		4			15		4	
Washington.....	20			145	109						26		10							2	
West Virginia.....	28			40	131	18															
Wisconsin.....	165			529	131		2				108	20	26	11		66			1	1	
Wyoming.....	5			17	10																
Total—U. S. A.....	2338	2	9	5424	11654	1021	750	24	27	1	596	55	791	341	137	174	45	107	88	157	6
Alberta.....	2			25	3																
British Columbia.....	10			12	10																
New Brunswick.....	4			20	1																
Nova Scotia.....	4			15	5																
Manitoba.....	3			4	3		2														
Ontario.....	76			410	64	6								10	3	16				5	
Quebec.....	13			24	24		1														
Saskatchewan.....	4			10	1																
Total—Canada.....	116			520	111	6	3							10	3	16				5	

STATES ISSUING ANNUAL REPORTS ON
ACCIDENTS AT RAILROAD-HIGHWAY CROSSINGS

In connection with Assignment 4—Develop statistics indicating by States and railroads the number and types of auto-manual and automatic highway crossing protection installations, the Committee was requested to report on what States issue annual reports showing number and details of accidents at railroad-highway crossings, both protected and unprotected. Of 21 States and the Dominion of Canada contacted, it was found that the following issue such reports:

Kentucky
Maine (biennial reports)
Maryland
Minnesota
Mississippi
New Hampshire (biennial reports)
New Mexico
New York
Pennsylvania
South Dakota
Tennessee
Texas
West Virginia
Wisconsin
Dominion of Canada

The Committee will pursue this matter and make a further report at the 1949 Annual Meeting.

Action Recommended

Acceptance as information.

AUTOMATIC TRAIN CONTROL AND AUTOMATIC CAB SIGNALS
IN THE UNITED STATES AS OF JANUARY 1, 1948

TABLE I
Automatic Train Control Installed as of January 1, 1948

Railroad	Type	Territory	Road Miles	Track	Equipped locomotives and motor cars
A. T. & S. F.	Union 3-Speed	Pequot, Ill.—Ft. Madison, Iowa	175.4	355.0	161
A. C. L. (1)	General Int.	Richmond, Va.—Florence, S. C.	298.9	589.2	224
B. & O.	General Int.	Point of Rocks, Md.—Philadelphia, Pa.	166.4	332.8	280
B. & A.	General Int.	Boston—Rensselaer, N. Y., and Brookline Jct.—Riverside, Mass.	208.3	502.7	164
B. & M. (2)	General Int.	Soapstone—North Adams, Mass.	8.6	19.5	—
C. & O.	Union Int.	Orange—Clifton Forge, Va.	123.4	123.4	90
(P. M. Dist.)	General Int.	Grand Rapids—Detroit, Mich.	135.0	146.0	147 (3)
C. & E. I. (4)	Miller Ramp	Dolton, Ill.—Jackson, Ind.	141.5	283.0	121
C. & N. W.	General 2-Speed	Chicago—Co. Bluffs, Iowa	506.3	1,031.6	300
C. C. C. & St. L.	General Int.	Indianapolis—Lenox, Ill.	235.2	384.5	288
Erie	General Int.	Port Jervis—Hornell, N. Y.	242.2	484.2	164
G. M. & O.	National Int.	Chicago—Bloomington, Ill.	113.8	203.5	61
H. & M. (5)	Auto. Trip	N. Y.—Hoboken and Jersey City	8.5	18.0	302
I. C.	Union Con. Stop	Champaign—Branch Jct., Ill., and Waterloo—Ft. Dodge, Iowa	219.6	343.5	193
L. V.	General Int.	Newark, N. J.—Sayre, Pa.	283.2	636.4	246
L. I.	Auto. Trip	Brook Tower—Brooklyn and East New York—Dunton and 4 Drawbridges	7.7	15.2	761
L. & N. (6)	Union 1-Speed	Corbin, Ky.—Etowah, Tenn.	161.7	161.7	52
	Union Con. Stop	Mobile, Ala.—New Orleans, La.	136.2	147.5	58
M. C. (7)	General Int.	Detroit—Kensington, Ill.			
		Detroit—Alexis, Ohio	315.5	631.0	252
N. Y. C. (8)	General Int.	Croton, N. Y.—Englewood, Ill., and Rochester—Suspension Bridge, N. Y.	1,031.5	3,325.6	1,001
N. Y. C. & St. L.	Union Int.	Ft. Wayne, Ind.—Chicago, Ill.	139.1	157.6	105
Penna. (9)	Auto. Trip	East and North River Tunnels	7.4	20.2	5

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Com. II—Auto. Train Control and Signals

Signal Section, A.A.R.

TABLE I—Continued

Railroad	Type	Territory	Miles		Equipped locomotives and motor cars
			Road	Track	
P. & L. E.	Union Int.	Pittsburgh, Pa.—Youngstown, Ohio	64.0	214.8	75
R. F. & P.	Union 2-Speed	Richmond—Pot. Riv. Bridge, Va.	109.7	232.0	74
Sou. Sys.	General Int.	Spencer, N. C.—Howell, Ga.			
		Salisbury, N. C.—Morristown, Tenn.			
		Hayne, S. C.—Biltmore, N. C.			
		Lot, Ky.—Holton, Tenn. (6)			
		Bristol, Va.—Ooltewah, Tenn.			
		Charlotte, N. C.—Columbia, S. C.			
		Stevenson, Ala.—Memphis, Tenn.			
		Citico, Tenn.—Jacksonville, Fla.			
		Austell, Ga.—Birmingham, Ala.			
		Haleyville—Jasper, Ala.			
S. P.	National Int.	Ludlow, Ky.—New Orleans, La.	2,716.8	3,489.0	838
		Oakland—Pittsburg, Cal., and			
		Gold Run—Truckee, Cal.	99.6	188.2	280
U. P. (10)	Union 1-Speed	Portland—The Dallas, Ore.	84.0	86.5	64
Total*			7,739.5	14,122.6	6,306

Notes:

- (1) Includes 2.8 miles of road and 5.7 miles of track on the R. F. & P.
- (2) Locomotives included in Table II.
- (3) Includes 31 locomotives in Canada.
- (4) Forty-five of the locomotives listed have composite equipment for operation over the C. C. C. & St. L.
- (5) Sixty-six of the locomotives listed are also equipped with automatic cab signals.
- (6) Includes 4.6 miles of road and track shown on both L. & N. and Sou.
- (7) Does not include 240.7 miles of road and 481.3 miles of track equipped in Canada; includes 58 locomotives operating over that track.
- (8) Includes 7.7 miles of road and 15.21 miles of track between Alexis and Swan Creek.
- (9) Includes 6.39 miles of road and 18.58 miles of track also equipped for cab signal operation.
- (10) Does not include 36 locomotives equipped for operation over both cab signal and train control territory, which are included in Table II.

* Does not include G. R. S. Cont. coded, 4 speed, on Key System, involving 9.75 road miles, 19.5 track miles, and 93 equipped locomotives and motor cars.

TABLE II

Automatic Cab Signals Installed as of January 1, 1948

Railroad	Union Cont.	Inds.	Territory	Road	Miles Track	Equipped locomotives and motor cars
B. & M. (1)	Non-code	2	W. Cambridge—E. Deerfield, Mass.	99.1	202.7	193
C. of N. J. (2)	Non-code	3	Red Bank—Lakehurst, N. J.			
	Code	4	Elizabeth—N. E. Raritan River, and			
	Code	4	Matawan—Atlantic Highlands, N. J.	49.5	64.0	60
C. M. St. P. & P.	Non-code	3	Portage, Wis.—Hastings, Minn.	209.9	417.1	142
C. R. I. & P.	Code	4	Blue Island—Rock Island, Ill.	166.0	332.0	132
D. L. & W.	Non-code	2	E. Buffalo, N. Y.—Scranton, Pa.	256.6	523.2	151
L. I. (3)	Code	3	Jamaica—Babylon, L. I.			
	Code	3	Harold Intkg.—Pt. Washington, L. I.			
	Code	3	Ewd. and Wwd. thru Harold Intkg. on			
			N. Y. con'g. R. R. tracks and North Side			
			Br. tracks	44.1	85.1	358
N. Y. & L. B. (4)	Code	4	N. E. Raritan River—Bay Head Jct., N. J.	39.6	78.0	—
N. Y. N. H. & H. (5)	Non-code	2	New Haven, Conn.—Springfield, Mass.			
	Code	4	New Haven, Conn.—Cranston, R. I.	162.8	358.7	272
N. & W.	Non-code	3	Roanoke, Va.—Hagerstown, Md.	238.7	251.6	79
Penna. Sys. (6)	Code	4	Washington—New York			
			Baltimore and Philadelphia—			
			Indianapolis, Ind.			
			Compitt Jct.—Kiskiminetas Jct., Pa.			
			"Shore," Pa.—Vernon, N. J.			
			"Harold" L. I. City—"JO"—"C"			
			Pa. Sta., N. Y. (East R. Tubes)			
			Jersey City—Hudson, N. J., and			
			Rahway—Woodbridge Jct.	1,307.0	3,608.1	2,797
P.-R. S. S. L.	Code	4	Camden—Atlantic City, N. J., and			
	Code	4	So. Camden—Winslow, N. J.	82.4	162.6	17
Reading	Code	4	Jenkintown—Bethlehem, Pa.	45.7	91.3	156
U. P. (7)	Non-code	2	N. Platte, Nebr.—Cheyenne, Wyo.	225.0	450.0	187
Total				2,926.4	6,624.4	4,219

(See notes on following page)

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Com. III—Auto. Train Control and Signals

Signal Section, A.A.R.

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TABLE II—Continued

Notes:

- (1) Includes 66 locomotives equipped with intermittent inductive automatic train stop in addition to cab signal equipment. These are included in total as they are not included in Table I.
- (2) Twenty-five of these locomotives have composite equipment for operation over both non-code and code cab-signal territory.
- (3) Includes 307 MU cars and 18 locomotives equipped with both automatic trip stop and cab signals. These (325) are not included in total, as they are included in Table I.
- (4) Locomotives same as C. of N. J. P. R. R. operates 20 equipped locomotives and 24 equipped motor cars over this territory.
- (5) One hundred and fourteen of these locomotives have composite equipment, 18 U. S. & S. and 96 G. R. S. for operation over both non-code and code cab-signal territory.
- (6) Includes 33.0 miles of road and 88.7 miles of track on the B. & O. (Newark—Columbus, Ohio), equipped for operation of cab-signal locomotives of Pennsylvania.
- (7) Includes 36 locomotives equipped to operate over both cab-signal and speed-control territory.

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Com. III—Auto. Train Control and Signals

Summary of Automatic Train Control and Automatic Cab Signals
in the United States as of January 1, 1948

	Road miles	Track miles
Automatic train control.....	7,739.5	14,122.6
Automatic cab signals.....	2,926.4	6,624.4
Total—automatic train control and cab signals.....	10,665.9	20,747.0
Locomotives equipped (includes motor cars and multiple-unit cars):		
Continuous control, speed control, and cab signals.....		651
Continuous control and cab signals.....		251
Intermittent control without speed control.....		5,079
Cab signals.....		4,544
Exclusively for operation over foreign lines.....		192
Total locomotives equipped.....		10,717

Action Recommended

Acceptance as information.

SHOW-CAUSE ORDERS ISSUED BY THE INTERSTATE COMMERCE
COMMISSION UNDER PARAGRAPH (b) SECTION 25 OF
INTERSTATE COMMERCE ACT FROM AUGUST 1946
TO DECEMBER 1947*

Docket 28750 Sub. No.	Date	Railroad	Show cause why it should not be required to:
26	8-28-46	M. P.	Install electric switch-locking at hand-operated switches controlling movements between sidings and main tracks on its lines where trains are operated by signal indication only. (On 11-11-46, the railroad filed a return to this order, in which it agreed, subject to approval by the Court, to install the electric switch-locks specified, and the railroad was required, in Order dated 11-27-46, to provide same on or before January 1, 1948. Upon application of M. P. dated 12-5-47, the completion date was extended to January 1, 1949, by I. C. C. Order, date 12-16-47.)

Action Recommended

Acceptance as information.

* Amending previous report in A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, p. 80-A.

HEARINGS SET BY THE INTERSTATE COMMERCE COMMISSION UNDER
THE SIGNAL INSPECTION ACT (DOCKET 28000) FOR THE YEAR 1947*

Docket 28000 Sub. No.	RS&I or BS-Ap No.	Railroad	Location	Proposed changes	Date held	Date granted	Date denied
101	RS&I 260 to 266, incl.	FtDDM&S	Various	Permanent relief from compliance with Secs. 305 and 310 of RS&I at following int'lkd. crossings: Rockwell City, Kelley, Gypsum, Ft. Dodge, Harcourt, Gowrie and Rinard, Iowa	1-23-47		2-18-47 (See Note 1)
102 and 103	BS-Ap Nos. 9182 and 9272	UP and IC	Between Enrose and Caldwell, Idaho, Martin, Tenn.	Modification of auto. block signal systems involving installation of flashing light aspects.	9-12-47 and further hearing 11-21-47	12-9-47	(See Note 2)

Notes:

1. Order required applicant to stop all its trains and locomotives at points named until Secs. 305 and 310 are complied with, as, also, were the intersecting lines (C&NW, CGW, and M&StL) at the following points: Kelley, Fort Dodge, Harcourt, Gowrie and Rinard.
2. The UP application (Sub. No. 102) was approved 12-9-47 upon condition that the flashing light aspect indicate "Proceed, train speed must immediately be reduced sufficiently to pass next signal at not exceeding 30 miles per hour." At the hearing on 11-21-47, the IC filed a motion to withdraw their application (Sub. No. 103); and it (the application) was dismissed by order of the Commission, dated 12-9-47.

* Previous report on this subject appears in A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, p. 79-A.

Summary

Year	No. Hearings			Disposition		
	Set	Held	Canceled	Granted	Denied	Dismissed
1938	3	3	—	1	2	—
1939	23	17	6	17	(See Note A)	✓
1940	18	18	—	10	7	1
1941	27	23	4	22	1	—
1942	21	19	2	17	2	—
1943	5	5	—	5	—	—
1944	—	—	—	—	—	—
1945	2	2	—	2	(See Note B)	—
1946	2	1	1	—	(See Note C)	1
1947	3	3	—	1	1	1 (Note 3)
Totals	104	91	13	75	13	3

Notes:

A—One of these denied in part.

B—An amended application in one of these was approved.

C—Application withdrawn at hearing.

Action Recommended

Acceptance as information.

TITLE 49—TRANSPORTATION AND RAILROADS
CHAPTER I—INTERSTATE COMMERCE COMMISSION
SUBCHAPTER A—GENERAL RULES AND REGULATIONSPART 136—INSTALLATION, INSPECTION, MAINTENANCE,
AND REPAIR OF SYSTEMS, DEVICES AND APPLIANCES

No. 29543

APPLIANCES, METHODS, AND SYSTEMS INTENDED TO
PROMOTE SAFETY OF RAILROAD OPERATION

At a Session of the Interstate Commerce Commission, Division 3, held at its office in Washington, D. C., on the 17th day of June, A. D. 1947.

It appearing, That the Commission under date of May 20, 1946, instituted, on its own motion, an investigation to determine whether it is necessary in the public interest to require any respondent to install block signal system, interlocking, automatic train stop, train control and/or cab signal devices, and/or other similar appliances, methods, and systems intended to promote the safety of railroad operation upon the whole or any part of its railroad on which any train is operated at a speed of 50 or more miles per hour, and whether the Rules, Standards and Instructions prescribed by the Commission's order of April 13, 1939 (49 CFR, Cum. Supp. 136), pursuant to the provisions of section 26 (now section 25) of the Interstate Commerce Act (49 U.S.C. 25) should be amended to include a revised definition of the term "medium speed" and a definition of the term "low (restricted) speed."

It further appearing, That all Class I and all switching and terminal railroads subject to the Interstate Commerce Act were made respondents to such investigation, and

It further appearing, That a full investigation of the matters and things involved has been made and that said division, on the date hereof, has made and filed a report containing its findings of fact and conclusions thereon, which said report is hereby referred to and made a part hereof:

It is ordered, That each respondent be, and it is hereby, notified and required to install on that part or parts of its lines over which any passenger train is operated at a speed of 60 or more miles per hour, or any freight train is operated at a speed of 50 or more miles per hour an automatic block signal system which shall conform to the rules, standards and instructions prescribed by the order of the Commission of April 13, 1939 (49 CFR, Cum. Supp., 136), as herein amended, or a manual block system which shall conform to the following conditions:

A passenger train will not be admitted to the block when occupied by another train, except under flag protection; no train will be admitted to the block when occupied by an opposing train or by a passenger train, except under flag protection; and a train other than a passenger train will not be

Previous order in connection with I. C. C. Docket No. 29543 appears in A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, p. 82-A.

permitted to follow a train other than a passenger train into the block except when authorized by a train order, permissive signal or prescribed form, and when such movement is so authorized the following train must proceed prepared to stop short of a train or obstruction, but not to exceed 15 miles per hour.

It is further ordered, That the installations required by the next preceding paragraph shall be made as follows:

When such installations are to be made on 100 or less miles of track, they shall be made on or before December 31, 1948.

When such installations are to be made on more than 100 miles of track, they shall be made on not less than 25 per cent of the miles of track, with a minimum of 100 miles, on or before December 31, 1948; on not less than 50 per cent of the miles of track, with a minimum of 200 miles or the total miles if less than 200, on or before December 31, 1949; on not less than 75 per cent of the miles of track, with a minimum of 300 miles or the total miles if less than 300, on or before December 31, 1950, and on all miles of track on or before December 31, 1951.

It is further ordered, That each respondent be, and it is hereby notified and required to install on that part or parts of its lines over which any passenger or freight train is operated at a speed of 80 or more miles per hour an automatic train stop or train control system or automatic continuously controlled cab signal system which shall conform to the rules, standards and instructions prescribed by the order of the Commission of April 13, 1939, as herein amended.

It is further ordered, That the installations required by the next preceding paragraph shall be made as follows:

When such installations are to be made on 100 or less miles of track, they shall be made on or before December 31, 1948.

When such installations are to be made on more than 100 miles of track they shall be made on 25 per cent of the miles of track, or 800 miles, whichever is less, with a minimum of 100 miles, on or before December 31, 1948; on 50 per cent of the miles of track, or 1600 miles, whichever is less, with a minimum of 200 miles or the total miles, whichever is less, on or before December 31, 1949; on 75 per cent of the miles of track, or 2400 miles, whichever is less, with a minimum of 300 miles or the total miles, whichever is less, on or before December 31, 1950; on 100 per cent of the miles of track, or 3200 miles, whichever is less, on or before December 31, 1951, and on all remaining miles of track on or before December 31, 1952.

It is further ordered, That the definition of "Medium Speed" in the rules, standards and instructions for the installation, inspection, maintenance and repair of systems, devices and appliances intended to promote the safety of railroad operation in accordance with section 26 (now section 25) of the Interstate Commerce Act, prescribed by the order of the Commission of April 13, 1939, be, and it is hereby, amended to read as follows:

§136.11 Definitions. ***

(q) *Speed*. (1) *Medium*. A speed not exceeding one-half authorized speed, but not exceeding 30 miles per hour.

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Com. III—Auto. Train Control and Signals

(2) *Low (Restricted) Speed.* A speed that will permit stopping short of another train or an obstruction, but not exceeding 15 miles per hour.

(AUTHORITY: 50 Stat. 836, 49 U.S.C. 25)

By the Commission, division 3.

(SEAL)

W. P. BARTEL,
Secretary.

NOTICE

INTERSTATE COMMERCE COMMISSION
Office of the Secretary
Washington

March 17, 1947.

INSTRUCTIONS GOVERNING APPLICATIONS UNDER SECTION 25 OF THE
INTERSTATE COMMERCE ACT FOR:

- I. APPROVAL OF DISCONTINUANCE OF MATERIAL MODIFICATION OF INSTALLATIONS OF BLOCK SIGNAL SYSTEMS, INTERLOCKING, AND AUTOMATIC TRAIN STOP, TRAIN CONTROL OR CAB SIGNAL DEVICES. (Section 25 (b)).
- II. APPROVAL OF MODIFICATIONS OF OR AUTHORITY TO DEPART FROM SECTIONS 305, 310, 533, 586, 587, 677 or 678, OF THE RULES, STANDARDS AND INSTRUCTIONS FOR INSTALLATION, INSPECTION, MAINTENANCE AND REPAIR OF SYSTEMS, DEVICES AND APPLIANCES INTENDED TO PROMOTE THE SAFETY OF RAILROAD OPERATION PRESCRIBED BY ORDER OF APRIL 13, 1939. (Section 25 (c)).

In filing applications with respect to the foregoing matters, the procedure outlined herein shall be followed:

1. Applications shall be submitted by the President, Vice President, General Manager, Receiver, Trustee or Chief Operating Officer, or other authorized officer.
2. A separate application should be filed for each project. If more than one carrier would be affected by the approval or authority sought, a joint application should be filed by all carriers affected.
3. The original and one copy of each application, with supporting papers, shall be filed.
4. Applications may be submitted in the form of a letter setting forth the required information.
5. Applications should be filed to cover the following:
 - (A) To discontinue, in whole or in part, the use of block signal systems, interlocking, automatic train stop, train control or cab signal devices; and of other similar systems, devices and appliances, the installation of which has been approved by the Commission.
 - (B) To make material modification in a block signal system, an interlocking, or an automatic train stop, train control, or cab signal device,

which involves change in type of system or appliances, or alters the functional operation of apparatus, the location of signals, the number of signals, the aspects displayed by signals, the location of interlocking stations, or the number of interlocking stations, or which results from a change in track arrangement.

6. Applications for approval of discontinuance or material modification of existing installations should show the following:

- (a) The corporate name of each applicant.
- (b) The manner in which each is involved.
- (c) The location of the project, giving name of operating division and nearest station.
- (d) Track or tracks involved.
- (e) Brief description of existing equipment and of proposed change.
- (f) Reason for proposed change.
- (g) Whether necessary expenditure has been authorized.
- (h) Action, if any, by state authorities.
- (i) Approximate dates of beginning and completion of project.
- (j) Changes in operating practices, temporary or permanent.
- (k) Whether safety of operation will be affected, and if so, how.
- (l) Whether proposed changes will conform to Commission's Rules, Standards and Instructions.
- (m) The information specified below, on a print or prints, to scale, or by indicated dimensions, using A.A.R. symbols, size 8" x 10½" or folded to 8" x 10½", namely present and proposed arrangements of tracks and signal facilities, in color, name of carrier, operating division, place and state, and time-table directions of movement; if stopping distances are involved, curvature and grade, maximum authorized speeds of trains, and the length of the signal control circuits for each indication displayed.

7. Applications for approval of modifications of, or for authority to depart from Sections 305, 310, 533, 586, 587, 677 or 678 of the Rules, Standards and Instructions, should show the following:

- (a) The corporate name of each applicant.
- (b) The manner in which each is involved.
- (c) The location of the project, giving name of operating division and nearest station.
- (d) Brief description of existing facilities.
- (e) The section numbers of the Rules, Standards and Instructions involved, and the specific modification, or authority which is desired.
- (f) Reason why the proposed modification or authority is desired.
- (g) Manner in which existing systems, devices, or appliances which it is proposed to continue, or others which it is proposed to substitute therefor, fail to conform to the sections enumerated, with prints if necessary to an understanding of the application.

8. Public notice of the filing of an application will be posted in the office of the Secretary of the Commission if the application is deemed of sufficient importance.

9. A protest against the granting of an application shall set forth specifically the grounds upon which it is made, and contain a concise statement of the interest of protestant in the proceeding. The original and one copy of any protest shall be filed with the Commission, and one copy shall be furnished to each applicant.

10. Correspondence in reference to applications should be addressed to Director, Bureau of Safety, Interstate Commerce Commission, Washington 25, D. C.

W. P. BARTEL,
Secretary.

Action Recommended

Acceptance as information.

TABULATION OF PETITIONS FILED WITH THE INTERSTATE COMMERCE COMMISSION
IN DOCKET NO. 29543

Railroad	Provisions of Order Affecting Present or Proposed Operations, Rules and Systems			Modification or Exceptions Sought	
		Track Miles Involved	Max. Auth. Speed M.P.H.		Track Miles Involved
Atchison, Topeka & Santa Fe	1. Installation of block signal systems for 50/60 speeds. 2. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more. 3. Definitions of Medium and Low (Restricted) speed.	6,000+	80+	1. Postponement of effective dates of time schedule for installation of auto. train stop, train control or cab signals for one year to permit installation of CTC on 185.3 miles of track. 2. Installation and operation of auto. train stop systems under which passenger locomotives only are equipped. 3. Operation of passenger trains at a max. authorized speed of 85 m.p.h. under auto. block signal protection. 4. Operation of passenger trains on other mileage at a max. authorized speed of 80 m.p.h. under auto. block signal protection. 5. Exception from use of Medium and Low (Restricted) speed definitions.	2,611 381.2
Atlanta & St. Andrews Bay				Have no scheduled speeds covered by order but request exception or modification in case those speeds may be exceeded on occasions.	
Bessemer & Lake Erie	1. Definitions of Medium and Low (Restrictive) speed.			1. Continue use of own definition of Medium Speed. 2. Modify definition of Low (Restricted) Speed.	
Boston & Maine (also Maine Central & Portland Terminal)	1. Definition of Medium Speed			1. Continue use of own definition of Medium Speed.	
Burlington-Rock Island	1. Installation of block signal systems for 50/60 speeds. 2. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	143.3 143.3	90 90	1. Exemption from order and order be so modified that the railroad may continue its present speeds with present system of operation.	143.3
Central of Georgia	1. Installation of block signal systems for 50/60 speeds.	182	50/70	1. Operation of trains at 50/70 speeds without installation of block signals.	182
Chesapeake & Ohio	1. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	403.6	85	1. Continue to operate passenger trains up to 85 m.p.h. without installation of appliances required by the order.	403.6

Chicago & Eastern Illinois	1. Manual block rule. 2. Installation of automatic train stop, train control or cab signals for speeds of 80 m.p.h. or more.	111.7 111.7		1. Exemption from order and order so modified that it can continue to operate trains at present speeds and under present system of operation.	111.7
Chicago & North Western	1. Installation of block signal systems for 50/60 speeds. 2. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	1,059.0 1,224.8	60 to 70 80 to 100	1. Exception from order; or order modified so the railroad can continue to operate trains at present speeds and under present system of operation.	2,283.8
Chicago, Burlington & Quincy	1. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more. 2. Installation of block signal systems for 50/60 speeds.	832.5 118	80 to 90	Exemption from order; or order so modified the railroad can continue to operate trains at present speeds and under present system of operation.	950.5
Chicago, Rock Island & Pacific	1. Installation of block signal systems for 50/60 speeds. 2. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	518.4 1,098.0	70 to 75 85 to 90	1. That order be set aside; and that such order be modified so that CRI&P can continue to operate at present speeds and under existing method of operation.	1,616.4
Chicago, St. Paul, Minneapolis & Omaha	1. Installation of block signal systems for 50/60 speeds. 2. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	540.9 356.2	60 to 75 100	Exception from order; or order so modified it can continue to operate trains at present speeds and under existing method of operation.	897.1
Colorado & Southern	1. Installation of block signal systems for 50/60 speeds.	429.3		That the road be excluded from the order of June 17.	429.3
Fort Worth & Denver City	1. Installation of block signal systems for 50/60 speeds. 2. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	428 66	65 to 90 90	1. Exemption from order and order be so modified that the railroad may continue its present speeds with present system of operation.	423
Great Northern	1. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	397.9	85	1. That order be vacated; or modified so G.N. can continue operation of passenger trains up to 85 m.p.h. without installation of auto. train control, train stop or cab signals.	397.9
Gulf, Mobile & Ohio	1. Installation of block signal systems for 50/60 speeds.	1,005.9	60 to 69+	1. That G.M.&O. be excepted from order; or order modified so it can continue to operate trains at present speeds and under existing method of operation.	1,005.9
Illinois Central	1. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	1,113 Road Miles	80+	1. Allow the operation of passenger trains at a speed of 80 m.p.h. without the installation of auto. train stop, train control or cab signals.	1,113
Illinois Terminal	1. Installation of block signal systems for 50/60 speeds.	53.5	60+	1. Continue to operate trains at present speeds and under present method of operation.	53.5

TABULATION OF PETITIONS FILED WITH THE INTERSTATE COMMERCE COMMISSION
IN DOCKET NO. 29543—Continued

Railroad	Provisions of Order Affecting Present or Proposed Operations, Rules and Systems			Modification or Exceptions Sought	
		Track Miles Involved	Max. Auth. Speed M.P.H.		Track Miles Involved
Minneapolis, St. P. & S. S. Marie (Wisconsin Central)	1. Installation of block signal systems for 50/60 speeds.	Not	given	1. That order be vacated; or so modified the petitioner can continue to operate trains under present method of operation.	
Missouri Pacific	1. Installation of block signal systems for 50/60 speeds. 2. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	1,565 1,128		1. Request extension of time to February 16, 1948, within which to file a petition or petitions for exceptions from order. (Note: ICC Order, dated 8/14/47, granted an extension to September 16, 1947.)	2,693
Nashville, Chattanooga & St. Louis	1. Installation of block signal systems for 50/60 speeds.	138.1	65	1. Continue to operate trains at present speeds and under present method of operation.	138.1
New York, New Haven & Hartford	1. Definitions of Medium and Low (Restricted) speed.			1. Continue use of own definitions of Medium and Restricted speed.	
Norfolk & Western	1. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	186.1	90	1. Continue to operate passenger trains at speeds not exceeding 90 m.p.h. without installing auto. train stop, train control or cab signals.	186.1
St. Louis-San Francisco	1. Installation of block signal systems for 50/60 speeds.	297.5	65 to 70	Exception from order; or modification to continue to operate trains at present speeds and under present method of operation.	297.5
St. Louis Southwestern	1. Installation of block signal systems for 50/60 speeds.	226.3	60+	1. Continue to operate trains at present speeds and under present method of operation, upon condition that auto. block signals be installed on all curves not now so protected.	226.3
Seaboard Air Line (also refers to Order, dated 4-29-46, Docket No. 28750 Sub. No. 23)	1. Installation of block signal systems for 50/60 speeds. 2. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	310.7 Anticipatory	60	1. That time schedule prescribed in Docket 29543 supersede that in Docket 28750 Sub. 23. 2. Reservation, until other signal mileage is completed, which will allow the determination as to whether the 310.7 miles shall be exempted. 3. Installation of auto. cab signal devices only on locomotives operated at 80 m.p.h. or more.	Anticipatory

Southern Pacific	1. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more. 2. Definitions of Medium and Low (Restricted) Speed.	634.5	80+	1. Excepted from order. 2. Install auto. train stop, train control or cab signals on only those locomotives used to handle trains authorized to operate at 80 m.p.h. or more. 3. Adopt its own definition of medium speed.	634.5
Spokane, Portland & Seattle	1. Installation of block signal systems for 50/60 speeds.	104.3	75	1. Extension of time to June 30, 1949 to complete installation of auto. block signals.	104.3
Texas & New Orleans	Not affected at present.			1. Request that order be amended in such manner that if it becomes necessary to increase speeds at any time in future it will be offered an opportunity for a hearing before the Commission.	
Texas & Pacific	1. Installation of block signal systems for 50/60 speeds. 2. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	112.5 1,132.9	60+ 80+ Anticipatory	1. Continue to operate trains at present speeds and under existing method of operation. 2. Excepted from installing auto. train stop, train control or cab signals; or that it be installed on only those engines to be operated in excess of 79 m.p.h. 3. That if any of the installations are required, an extension of time be granted to compensate for time date of order on the petition becomes final.	112.5 1,132.9
Toledo, Peoria & Western	1. Installation of block signal systems for 50/60 speeds.	130.6	60	1. Permission to operate trains not to exceed 60 m.p.h. under present method of operation.	130.6
Union Pacific	1. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more. * Includes 101 miles trackage rights on A.T. & S.F.	993 1,354* Road Miles	90	1. Continue to operate streamline passenger trains at 90 m.p.h. without installation of auto. train stop, train control or cab signals.	1,354 Road Miles
Wabash	1. Manual block rule. 2. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more.	128.5 1,442.8	50 80 to 90	1. Permit the operation of passenger trains at speeds now operated without installation of auto. train stop, train control or cab signals; or, if not granted, an extension of time to Dec. 31, 1947 be granted for further study and filing of an amended petition.	1,571.3
Western Pacific	1. Installation of auto. train stop, train control or cab signals for speeds of 80 m.p.h. or more. 2. Definition of medium speed.	291.9* *136.4 miles of which is paired 3. track with S.P.	80+	1. Excepted from order. 2. Install auto. train stop, train control or cab signals on only those locomotives authorized to operate at speeds of 80 m.p.h. or more. Adopt own definition of medium speed.	

Action Recommended

Acceptance as information.

Sept. 1948]

Com. III—Auto. Train Control and Signals

Signal Section, A.A.R.

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COMMITTEE IV—AUTOMATIC BLOCK SIGNALING

Personnel

E. N. Fox, Chairman

L. B. Yarbrough, Vice-Chairman

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C. E. Hartvig	H. G. Stiebeling
J. R. Heisler	R. E. Taylor

W. G. Trost

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Report on protection against lightning.
4. Report on methods and circuits for economically providing multiple signal controls over a minimum number of wires for coded systems, except where electronic methods are used exclusively.
5. Specifications for various units comprising centralized traffic control, collaborating with Committee II.
6. Investigate and report on methods of improving shunting of track circuits.
7. Investigate and report on means of overcoming effects of stray grounded current from high tension power lines on signal track circuits.
8. Investigate and report on the use of automatic block systems, with superimposed control.
9. Investigate and report on the use of track instruments instead of track circuits for the release of electric switch locks and electric locking.
10. Investigate and recommend proper grinding of bonding drills.
11. Specification for selenium rectifier.
12. Specification for high voltage lightning arresters—various voltage ranges.
13. Investigate and report on the practicability of in-service tests of all types of lightning arresters.
14. Investigate and report on grounding of signal power supply transformers.
15. Investigate and report on devices for sanding of rail, or equivalent which will eliminate track circuit shunt failures due to sand.
16. Investigate and report on the various types of power for operating signaling systems and the operating cost therefor.

17. Investigate and report on transposition requirements in erection of signal power lines (joint signal-communication line construction).

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Specification 178-42, Manual Part 141.
Revision of Specification 179-45, Manual Part 142.
Revision and consolidation of Requisites for A.C. and D.C. Coded Signal Systems and Requisites for Automatic Block Signaling Circuits, Manual Parts 46 and 34.
5. Specification 233-48.
Specification 234-48.
Specification 235-48.
6. Progress report on new developments in methods of improving shunting of track circuits.
8. Automatic block signals with superimposed control on the Chicago, Milwaukee, St. Paul & Pacific R.R.
10. Progress report on proper grinding of bonding drills.
11. Specification 229-48.
14. Grounding of signal power supply transformers.
15. Progress report on improvements in sanding devices.
16. Cooperative report—American Petroleum Institute—Correlating Committee on Cathodic Protection.

Explanatory

Specification 233-48 provides full information for those requiring a voice pass filter for use between two adjacent sections of a coded control system, or between a coded control system line and a telephone line, for through voice (approximately 300 to 3,000 cycles) transmission only. This filter will block direct current code and effectively attenuate all coded carrier control frequencies.

Specification 234-48 provides full information for those requiring a voice and Type H pass filter for use between adjacent sections of a coded control system, or between a coded control system line and a telephone line, for through voice (approximately 300 to 3,000 cycles) and Type H carrier (approximately 4,000 to 10,000 cycles) only. This filter will block direct current code and effectively attenuate coded carrier control frequencies above those used in the Type H carrier system.

Specification 235-48 provides full information for those requiring a voice and carrier pass filter for use between adjacent sections of a coded control system, or between a coded control system line and a telephone line, for through voice (approximately 300 to 3,000 cycles) and carrier frequencies (approximately 4.0 kilocycles to 75 kilocycles) only. This filter will block direct current code.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 17, 1948.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

National Electrical Safety Code—Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Disposition of 1947 Letter Ballot Subjects

The following subjects presented by this Committee in the 1947 Annual Meeting Advance Notice were submitted to letter ballot and officially approved:

Specification 44-47—Highway Crossing Bell—Now in Manual Part 21.

Specification 220-47—Electric Switch Lamp—Now in Manual Part 226.

Specification 222-47—Color Light Switch Signal—Now in Manual Part 227.

Specification 224-47—Centralized Traffic Control Neutral Direct Current Relay—Now in Manual Part 228.

Specification 225-47—Low Pass Filter for Centralized Traffic Control Lines Where Telephone Circuit is Superimposed—Now in Manual Part 229.

Specification 226-47—Tuned Alternator—Now in Manual Part 230.

Specification 74-47—Impedance Bond—Now in Manual Part 67.

Specification 221-47—Retained Neutral Polarized Relay—Now in Manual Part 231.

Specification 228-47—Tractive Armature Direct Current Biased Neutral Relay—Now in Manual Part 232.

(Revision of A.A.R. Signal Section Specification 178-42)
A.A.R. SIGNAL SECTION SPECIFICATION 178-48.

WELDED TYPE RAIL HEAD BONDS AND TRACK CIRCUIT CONNECTORS

Present

1. *Purpose.*

(a) This specification is for the purpose of providing welded type rail head bonds and track circuit connectors for track circuits where rails do not carry return propulsion current. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

Proposed

1. *Purpose.*

(a) This specification is for the purpose of providing welded type rail head bonds and track circuit connectors for track circuits. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Section 1 of Specification 178-42—Welded Type Rail Head Bonds and Track Circuit Connectors, Manual Part 141.

(Revision of A.A.R. Signal Section Specification 179-45)
A.A.R. SIGNAL SECTION SPECIFICATION 179-48.

MECHANICALLY APPLIED RAIL HEAD TYPE BONDS AND TRACK CIRCUIT CONNECTORS

Present

1. *Purpose.*

(a) This specification is for the purpose of providing mechanically applied rail head type bonds and track circuit connectors for track circuits where rails do not carry return propulsion current. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

Proposed

1. *Purpose.*

(a) This specification is for the purpose of providing mechanically applied rail head type bonds and track circuit connectors for track circuits. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Section 1 of Specification 179-45—Mechanically Applied Rail Head Type Bonds and Track Circuit Connectors, Manual Part 142.

PROGRESS REPORT

PROPER GRINDING OF BONDING DRILLS

The Committee expanded the scope of the assignment to cover other elements entering into drilling operations as related to bond applications. Questionnaire (Inquiry SS-75A) was issued November 10, 1947 to Voting Representatives of Member Roads in the Signal Section for the purpose of obtaining information on user experience over a wider area and period to prepare a report and make recommendations.

Replies were received from 88 railroads having 986 votes, which is approximately 59 per cent of the railroads and 86 per cent of the votes.

Of the replies received, those from 24 railroads (126 votes) did not contain sufficient data to enter in the tabulations, mainly because these replies were from railroads having little or no signaling and others were using welded bonds or had limited experience with bonding drills.

The balance of the replies representing 64 railroads (860 votes), which is approximately 43 per cent of the railroads and 76 per cent of the votes, were considered in the tabulations. Some of these replies were not fully complete on all questions, which explains why the answers to the individual questions do not check with these totals.

As the Signal Section votes are a reasonable approximation of the signaling on the Member Roads, they were considered by the Committee to be a fair basis for calculating the approximate percentages used in the following tabulations. Thus a railroad with a larger number of votes was considered to have had more experience than one with a lesser number of votes. Where the votes were approximately equal then the group having the largest number of railroads was considered to indicate the preferred practice.

Following is a summary of replies:

1. Has your recent use of bonding drills been satisfactory for the following:

(a) Web of rail drilling

	Yes	No
53 railroads.....	696	
5 railroads.....		114
Percentage.....	86	14

Of the 114 votes reporting unsatisfactory drilling, 67 per cent made competitive purchase, 55 per cent did not purchase precision ground drills, all railroads reground drills on special machines, 54 per cent did not use preferred grinding wheels, none of the railroads reground new drills before using, all railroads reground drills at one or more central points, 55 per cent did not use preferred point angle and lip clearance, 75 per cent did not report on drill speed and 75 per cent did not have any drilling instructions in use.

(b) Head of rail drilling (non-end hardened)

	Yes	No
39 railroads.....	557	
6 railroads.....		124
Percentage.....	82	18

Of the 124 votes reporting unsatisfactory drilling, 61 per cent made competitive purchase, 59 per cent did not purchase precision ground drills, all railroads reground drills on special machine, 57 per cent did not use preferred grinding wheels, none of the railroads reground new drills before using, all railroads reground drills at one or more central points, 59 per cent did not use the preferred point angle or lip clearance, 69 per cent did not report on drill speed and 77 per cent did not have any drilling instructions in use.

(c) Head of rail drilling (end hardened)

	Yes	No
18 railroads.....	160	
26 railroads.....		441
Percentage.....	27	73

Of the 441 votes reporting unsatisfactory drilling, 55 per cent made competitive purchase, 65 per cent did not purchase precision ground drills, 18 per cent did not regrind drills on special precision machine, 84 per cent did not use preferred grinding wheels, 31 per cent did regrind new drills before using, 5 per cent did not regrind drills at one or more central points, 68 per cent did not use the preferred point angle and lip clearance, 63 per cent did not use preferred drill speeds and 66 per cent did not have any drilling instructions in use.

2. State how your bonding drills have been purchased.

	Railroads	Votes	Percentage
Single manufacturer's brand name	27	288	33
Limited manufacturer's brand names.....	15	152	18
Competitive purchase.....	21	419	49
Railroad specification.....	None	None	—

3. Are your bonding drills purchased as "machine precision ground" or equivalent description to prevent receiving hand ground drills?

	Yes	No
27 railroads.....	289	
35 railroads.....		566
Percentage.....	34	66

4. Do you grind bonding drills on a special precision machine having micrometer adjustment?

	Yes	No
41 railroads.....	653	
23 railroads.....		207
Percentage.....	76	24

5. What type of grinding wheels have you found to give the best results?

Abrasive			
	Railroads	Votes	Percentage
Aluminum oxide.....	20	431	63
Silicon carbide.....	8	113	16
Undetermined.....	20	142	21

Grain			
	Railroads	Votes	Percentage
14.....	1	1	—
24.....	1	23	3
30.....	2	2	—
38.....	5	30	5
46.....	1	14	2
60.....	13	205	31
80.....	8	127	19
100.....	3	63	10
Undetermined.....	8	196	30

Grade			
	Railroads	Votes	Percentage
H.....	2	53	9
I.....	2	11	2
J.....	6	31	6
K.....	5	134	24
L.....	3	52	9
M.....	11	123	22
N.....	1	1	—
O.....	1	10	2
Undetermined.....	6	143	26

6. Do you regrind bonding drills as received from manufacturer before using?

	Yes	No
9 railroads.....	178	
55 railroads.....		682
Percentage.....	21	79

Individual railroads regrinding drills as received from the manufacturers stated the reasons as follows:

To insure proper sharpening.

New drills sometimes drill oversize holes.

New drills when received are not properly centered and of uneven lengths.

Only 70 per cent of drills received from manufacturer will drill a "go" hole for rail head type bonds as they become slightly dull in use.

Other railroads reported that tests of regrinding new drills as compared to using them as furnished were about equal.

7. Do you regrind all used drills at one or more central point and redistribute to the field maintenance and construction forces?

	Yes	No
51 railroads.....	658	
9 railroads.....		104
Percentage.....	86	14

8. What point angle and lip clearance have you found gives the best results?

 $\frac{9}{32}$ Inch Included Point Angle

Degrees	Railroads	Votes	Percentage
118.....	13	159	42
130.....	4	68	18
135.....	2	3	1
137 $\frac{1}{2}$	4	120	31
143.....	5	30	8

 $\frac{3}{8}$ Inch Included Point Angle

Degrees	Railroads	Votes	Percentage
118.....	26	398	51
125.....	1	15	2
130.....	5	78	10
132.....	1	24	3
135.....	12	217	27
138.....	1	21	3
143.....	6	33	4

 $\frac{9}{32}$ Inch Lip Clearance

Degrees	Railroads	Votes	Percentage
6.....	13	88	23
10.....	9	148	39
12.....	6	144	38

 $\frac{3}{8}$ Inch Lip Clearance

Degrees	Railroads	Votes	Percentage
6.....	15	127	17
10.....	14	222	30
12.....	21	399	53

9. What drill speeds in RPM have you found to give the best performance in drilling performance and drill life?

 $\frac{9}{32}$ Inch Web Drilling

RPM	Railroads	Votes	Percentage
200.....	2	2	1
250.....	7	70	49
300.....	2	53	38
500.....	1	17	12

 $\frac{3}{8}$ Inch Web Drilling

RPM	Railroads	Votes	Percentage
125.....	1	10	2
180.....	1	38	7
225.....	3	93	16
250.....	11	170	30
280.....	1	24	4
300.....	10	191	34
350.....	1	21	4
500.....	1	15	3

$\frac{3}{8}$ Inch Head of Rail Drilling

RPM	Railroads	Votes	Percentage
200.....	5	30	6
225.....	4	103	21
250.....	7	141	28
300.....	11	192	38
350.....	1	21	4
500.....	2	16	3

10. State approximate number of holes you feel that bonding drills should average to give satisfactory performance.

New $\frac{1}{32}$ Inch Web

Holes	Railroads	Votes	Percentage
0 to 50.....	5	56	25
51 to 75.....	7	72	31
76 to 100.....	6	76	33
101 to 150.....	1	2	1
151 to 200.....	2	24	10

1st Regrind $\frac{1}{32}$ Inch Web

Holes	Railroads	Votes	Percentage
0 to 50.....	12	128	60
51 to 75.....	None	None	—
76 to 100.....	6	86	40
101 to 150.....	1	1	—
151 to 200.....	None	None	—

2nd Regrind $\frac{1}{32}$ Inch Web

Holes	Railroads	Votes	Percentage
0 to 50.....	11	124	59
51 to 75.....	6	85	41
76 to 100.....	None	None	—

Total for Life of Drill $\frac{1}{32}$ Inch Web

Holes	Railroads	Votes	Percentage
0 to 100.....	1	1	—
101 to 200.....	9	77	37
201 to 300.....	4	62	30
301 to 400.....	2	24	11
401 to 500.....	1	46	22

New $\frac{3}{8}$ Inch Web

Holes	Railroads	Votes	Percentage
0 to 50.....	9	138	22
51 to 75.....	10	144	23
76 to 100.....	7	79	12
101 to 150.....	6	150	24
151 to 200.....	5	123	19

1st Regrind $\frac{3}{8}$ Inch Web

Holes	Railroads	Votes	Percentage
0 to 50.....	23	392	59
51 to 75.....	2	32	5
76 to 100.....	7	119	17
101 to 150.....	5	128	19
151 to 200.....	None	None	—

2nd Regrind $\frac{3}{8}$ Inch Web

Holes	Railroads	Votes	Percentage
0 to 50.....	23	398	65
51 to 75.....	5	114	19
76 to 100.....	5	103	16
101 to 125.....	None	None	—

Total for Life of Drill $\frac{3}{8}$ Inch Web

Holes	Railroads	Votes	Percentage
0 to 100.....	4	38	6
101 to 200.....	18	297	46
201 to 300.....	7	138	21
301 to 400.....	1	23	4
401 to 500.....	5	146	23

New $\frac{3}{8}$ Inch Head of Rail

Holes	Railroads	Votes	Percentage
0 to 50.....	5	57	10
51 to 75.....	3	52	9
76 to 100.....	6	124	21
101 to 150.....	15	233	38
151 to 200.....	7	130	22

1st Regrind $\frac{3}{8}$ Inch Head of Rail

Holes	Railroads	Votes	Percentage
0 to 50.....	10	198	33
51 to 75.....	3	91	15
76 to 100.....	13	170	28
101 to 150.....	6	106	18
151 to 200.....	2	39	6

2nd Regrind $\frac{3}{8}$ Inch Head of Rail

Holes	Railroads	Votes	Percentage
0 to 50.....	18	290	48
51 to 75.....	6	142	24
76 to 100.....	9	170	28
101 to 125.....	None	None	—

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Com. IV—Automatic Block Signaling

Total for Life of Drill $\frac{3}{8}$ Inch Head of Rail

Holes	Railroads	Votes	Percentage
0 to 100.....	3	30	5
101 to 200.....	7	160	27
201 to 300.....	11	153	26
301 to 400.....	5	88	16
401 to 500.....	7	153	26

11. State whether you have any special training or instruction methods in use for operators of drilling machines.

	Yes	No
*20 railroads.....	350	
42 railroads.....		499
Percentage.....	41	59

*Some railroads reported limited instructions in use or personal instruction by qualified operators or supervisory forces.

12. Additional remarks pertinent to subject as reported by individual railroads.

Registering speed indicators are used to check RPM of the bonding machines.

Many drills were ruined by leaving in the machine too long.

Experience has been that 1st reground drills average more holes than new drills.

After analyzing the replies to the questionnaire and discussions with manufacturers, the Committee recommends that any railroad not satisfied with their use of bonding drills and performance adopt the following practices:

1. Purchase bonding drills under limited manufacturer's brand names. Orders should specify machine precision ground drills point angle of 118 degrees and lip clearance of 10 degrees.

2. Railroads should not find it necessary to reground new drills.

3. All used drills should be reground at one or more central points on a special precision machine having micrometer adjustment.

4. Grinding wheels should be of aluminum oxide abrasive, 60 grain size and M grade. Drills should always be reground on dry wheels and never dipped in water or other liquid for cooling.

5. Drill speeds should normally not exceed 250 RPM. In many cases, especially on some end hardened rail, railroads may find it necessary to reduce drill speeds to 200 RPM or lower to secure satisfactory results.

6. By experiment and trial some railroads may find that slight variations in these recommendations will suit their particular needs better.

Action Recommended

Acceptance as information.

(Revision and Consolidation of Requisites for A.C. and D.C. Coded Signal Systems and Requisites for Automatic Block Signaling Circuits)
A.A.R. SIGNAL SECTION REQUISITES.

AUTOMATIC BLOCK SIGNALING CIRCUITS

1948

1. General.

(a) Automatic block signal circuits may be coded or non-coded and operated by direct current, alternating current, rectified alternating current or a.c. or d.c. coded current.

2. Track circuits.

(a) Track circuits shall, as far as practicable, be so designed and connected that the track relay will be in the de-energized position when:

1. A rail is broken or a rail or frog is removed.

2. A train, engine or car occupies any part of a track circuit including the fouling section of turnouts.

3. Where switch shunting circuit is used:

(a) A switch is misplaced or its points not in proper position.

(b) A switch is not properly locked where facing point lock with switch circuit controller is used.

(c) An independently operated fouling point derail equipped with switch circuit controller is misplaced or not in derailing position.

(b) Track circuit fouling protection shall conform to Form 7004, Manual Part 206.

(c) Direct current track circuits shall be designed to meet the requirements of Tables of Minimum Allowable Resistance in Series with Track Battery for Standard or Conventional Direct Current Track Circuits, Manual Part 132.

(d) Bonding shall be in accordance with Specification 135, Manual Part 22.

(e) Where relayed cut-section is used, the track relay at cut-section shall, when in de-energized position, open the track energy supply for the adjacent track circuit, and in non-coded direct current territory shunt the adjacent track circuit.

(f) Each track circuit, except where impracticable due to special conditions, and where single-rail track circuits are used, shall be insulated from all adjoining track circuits and from all non-track-circuited track.

(g) Track circuits shall, as far as practicable, be designed and so connected that energy from an adjoining track section through a defective or bridged insulating joint will not cause a less restrictive indication than intended.

(h) The length of any section of track circuit, except for trap circuits, shall be greater than the maximum inner wheel base of any engine or car.

(i) The maximum length of track circuits in electrified territory shall be not greater than will provide a safe margin of broken-rail protection with the ballast leakage and spacing of traction cross-bonding that obtains.

(j) Where dead sections exceed 35 ft. or the shortest wheel base of an engine, special circuits shall be installed.

(k) Location of insulated joints shall conform to Drawings 1634, 1635, 1636 and 1638.

2. *Track circuits.*—Continued.

(l) Electrical energy for non-coded direct current track circuits shall, when practicable, be connected to feed away from electric railroad crossings.

(m) The relays of coded track circuits on tracks signaled in one direction only and the effective relay for selected direction on tracks signaled in both directions, should be at the entering end of the circuit.

3. *Signal operating circuits.*

(a) Both sides of the 45 and 90 deg. semaphore signal hold clear circuits, and at least one side of the motor circuit, shall be controlled through the contacts of the "H" relay or relays, or through the neutral contacts of the polar "HD" relay, and in addition one side of the 90 deg. hold clear and motor circuits shall be controlled through the contact of the "D" relay or the equivalent polar contact of the "HD" relay.

(b) One side of the lamp circuit of a light signal giving indications by control of lamp circuits shall be controlled through the neutral contacts of the "H" relay or relays. The lamp circuit of the proceed indication shall, in addition, be controlled through the "D" relay or equivalent contact of the polar "HD" relay.

(c) Both sides of local operating circuit of searchlight type signal shall be controlled through contacts of the "H," "D," or "HD" relay where used.

(d) The circuit shall be so designed that:

1. As far as practicable, when the indication of a signal is changing, there shall be but one indication displayed.

2. The failure of any part of the circuit controlling the indication intended to be displayed shall not cause the signal to display a more favorable indication.

3. The failure of a lamp in a light signal shall not cause the signal to display a more favorable indication than intended.

4. *Non-code circuits.*

(a) Signal control circuit shall not be controlled through the contacts of indicator or annunciator in which the indicating element is attached to the armature.

(b) The battery or power supply shall be applied at the end of signal control circuit farthest from the relay or function operated.

(c) The signal control circuit shall preferably be controlled through track relays within the entire block instead of track repeater relays; for additional protection, both sides of the circuit may be controlled and when the track relay is in de-energized position the relay end of circuit may be shunted.

(d) Where switch shunting circuits or relayed cut-sections are not used, one or both sides of the "H" relay circuit shall be controlled through a switch circuit controller or its repeating relay connected to each switch and independently operated fouling point derail when so equipped in the block, and the

4. *Non-code circuits.*—Continued.

circuit shall be opened and relay end of circuit shunted when a switch is misplaced or its points are not in proper closed position or a derail is not in derailing position.

5. *Code circuits.*

(a) The code may be transmitted by use of either alternating or direct current. If alternating current is used, the frequency shall be such as to insure immunity from interference.

(b) The code form and frequency shall be the same as for cab signals, where used.

(c) Code producing apparatus shall deliver a substantially uniform code.

(d) Decoding apparatus shall be so designed that any damage to tuned equipment will not cause the signal to display a more favorable indication than intended.

(e) Code-following relays shall be so designed that they will repeat a given code without more distortion than is permitted, under the practical operating conditions, by the decoding apparatus.

(f) Any code used to transmit a signal indication more favorable than "Track clear to next signal," shall be selected over the relays controlling the signal and the proper relays or circuit controllers at the leaving end of the block.

1. Where color light or semaphore signals are used, the code shall be selected over contacts connected with the signal operating mechanism or over relays which repeat the position of these contacts.

2. Where light signals giving indication by control of lamp circuits are used, one side of the code selecting circuits shall be taken over the same relays that control the lamp circuits.

6. *Circuit design.*

(a) The circuits shall be so designed that:

1. As far as practicable, the failure of any part of a circuit affecting the control of a signal shall not cause the signal to display a more favorable indication than intended.

2. When a train or car is in the block, a switch is misplaced or its points are not in proper position, an independently operated fouling point derail equipped with switch circuit controller is misplaced or not in derailing position, or a track or signal control relay is in de-energized position, or, as far as practicable, a rail is broken or rail or frog is removed, the signal or signals protecting a train movement into the block shall display the proper restrictive indication.

3. As far as practicable, crossover between main tracks shall be provided with protection that will minimize the possibility of a train, engine or car occupying the crossover and signals on either track displaying other than proper restrictive indication.

4. When there are no broken rails, rails or frogs removed, no train or car in the block, all switches and independently operated fouling point derails in the normal position, all track and signal control relays in en-

6. *Circuit design.*—Continued.

ergized position, the signal or signals protecting the block shall display the proper indication for approaching train to proceed.

5. On track signaled for movements in both directions, signals shall be so controlled that proper restrictive indications will be provided to protect both following and opposing movements.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Requisites for A.C. and D.C. Coded Signal Systems, Manual Part 46,
and Requisites for Automatic Block Signaling Circuits,
Manual Part 34.

PROGRESS REPORT

NEW DEVELOPMENTS IN METHODS OF IMPROVING
SHUNTING OF TRACK CIRCUITS**Improved relays.*

Relays have recently been made available which provide a marked improvement in track shunting with respect to the following factors:

1. The degree of over-energization that may exist when track is dry and with high ballast resistance, after the circuit has been adjusted to just provide working current for the relay with the track wet and ballast resistance low.

2. The ratio of the drop-away current value to the working current value.

A 0.5-ohm relay of this type has been developed for operating a maximum length of 6,000 feet for track circuits having ballast resistance as low as 3 ohms per 1,000 feet. This is the ideal arrangement for maximum efficiency on such a track circuit since the relay resistance matches the net ballast resistance and thus minimizes the degree of over-energization in dry weather.

The advantages would also be present on tracks having lower ballast resistance than 3 ohms per 1,000 feet by reducing the length of the track circuit accordingly. Higher relay resistances, such as 2-ohm and 4-ohm, are available for shorter track circuits and where the net minimum ballast resistance approximately equals the relay resistance.

The relay is provided with two front and back contacts only and has a ratio of drop-away current to working current of 80 per cent instead of 53 per cent (new relay values) for relays previously available in accordance with Specification 105, Manual Part 123.

The relay, having only two contacts, and the use of non-aging magnetic iron in its construction, which minimizes the possibility of change in characteristics in service, can be given a service tolerance as high as 85 per cent of the new relay value instead of the present tolerance of 67 per cent.

The high drop-away ratio and the high service drop-away value of these relays, permits a marked improvement in track circuit shunting.

A comparison of the ratio of drop-away current to working current as provided for in Specification 105, Manual Part 123, and that provided by the new relay is as follows:

	Per cent
4 point relay Specification 105 (new relay).....	53
4 point relay Specification 105 service value 67 1/2 per cent of new relay	35.5
4 point relay Specification 105 if service value is 85 per cent of new relay.....	45
New high ratio relay (new relay).....	80
New high ratio relay, service value 85 per cent of new relay.....	68

* Previous report on this subject appears in the 1946 Annual Meeting Advance Notice (A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, p. 92).

Test of Cadwell thermit metal on rail heads for protection against loss of shunt due to rust.

The purpose of this test, which is being made by one of the railroads, is principally to determine the life of the metal under traffic. A crossover between main track and siding which was used daily was selected for the test and application was made as follows:

First—The rail head was cleaned of scale, dirt and rust by a power-driven emery wheel for a width of approximately $1\frac{1}{2}$ inches.

Second—Graphite mold, 1 foot long, was clamped on top of rail, filled with thermit powder and ignited, and mold immediately removed. The metal was deposited on rail head in an irregular mass about $\frac{1}{8}$ inch high and $\frac{5}{8}$ inch wide. The metal was firmly attached to rail head in approximately 1 inch areas about $\frac{1}{16}$ inch apart.

As train and engines operated over this crossover, the deposited metal gradually rolled down and finally the metal was worn down to the rail head, leaving a series of spots where the bronze had welded into the rail.

Installation was made July 8, 1947 and the metal was worn down to the rail head by October 16, 1947. Estimated traffic in 100 days: 11,700 cars and 2,100 engines.

The last inspection, made January 16, 1948, showed that the welded spots were still intact. Test will be continued.

No figures are available as to the cost of installation, but it is believed the labor cost will be rather high.

Test of stainless steel bead applied to an experimental track circuit in signal company yard.

One of the signal companies advise that they have been making some observations with stainless steel beads applied to an experimental track circuit on one of their yard tracks.

The track circuit is 238 feet long with 44 feet equipped with modified rail surface. Thirty-three feet of the 44 feet is equipped with stainless steel beads of 18-8 welding rod stabilized with columbium, and 11 feet with 25-20 stainless steel beads.

The rails to which the stainless steel bead was applied were placed on a planer and a "V" groove $\frac{3}{8}$ inch wide at the top and $\frac{3}{16}$ inch deep was cut in the top at the center. The welding rod was welded into the groove so that the bead projected some distance above the top of the rail. After welding, the bead was planed off so that the height above the rail head was approximately $\frac{1}{32}$ inch.

Tests for shunting sensitivity were made using a 337 lb. cylindrical bar rolling along the track. Each end of the bar was equipped with a polished stainless steel sleeve for making contact with the rails.

A marked improvement in shunting sensitivity was observed on the sections treated with welded beads as compared to the natural rail surface. Results were the same with both types of stainless steel.

There was no difficulty encountered in decreased shunting sensitivity due to accumulation of dirt on the stainless steel bead, except that there were variables in readings taken from time to time when rail voltages were less than 1 volt. When rail voltage was 1 volt or more there were no differences in shunting sensitivity readings made at different times.

They further advise that their tests included stainless steel 19-9 rod welded to the top of the rail without grooving the rail. The bead was ground down with a hand grinder to a height of $\frac{1}{32}$ inch to $\frac{1}{16}$ inch. There was difficulty in controlling the height, the grinder burned the bead in spots and spots of rust coating later appeared. Rails treated in this manner showed some improvement in shunting sensitivity but considerably less than obtained with the bead welded into a "V" groove.

Action Recommended

Acceptance as information.

PROGRESS REPORT

IMPROVEMENTS IN SANDING DEVICES

Traction sanders.

There is now available a sanding device for use on locomotives which uses a comparatively small amount of sand. The amount of sand used can be regulated to about $1\frac{1}{2}$ lbs. per minute. The report is that with the use of this device the sand remaining on the rail after the engine has run over the sanded track is scarcely noticeable.

The sand is delivered through a $\frac{1}{2}$ inch nozzle mounted at such an angle that the sand is blown into the point of contact between the wheel and rail. The device is under the control of the engineman and employs main reservoir air to blow the sand through the nozzle. Nozzles are provided for sanding for reverse as well as forward movement. Sharp sand must be used.

One railroad has several locomotives equipped with this device and has made a test of the effect of application of sand on a track circuit 875 feet long equipped with a 2-ohm relay.

The locomotive used had a wheel arrangement of 4-8-4 and was equipped with six sand nozzles, one ahead of each of the first and second pair of driving wheels and one nozzle on each side for reverse movements. The following results were obtained:

	Current to rail, amp.	Rail voltage battery end, volts	Current to relay, amp.	Rail voltage relay end, volt
Unoccupied.....	0.370	1.1	0.316	0.60
Engine standing. No sand.....	0.650	—	0.0	0.0
Engine moving and sanding....	0.650	—	0.0	0.0
Engine stopped. All wheels on sanded track.....	0.650	—	0.0	0.0

Braking sanders.

One railroad reports that on Diesel-powered streamliners they have been installing on each car a sanding device to prevent sliding of wheels when braking.

Sand nozzles are located on each side of the car mounted at such angle as to apply the sand by air pressure at the point of contact of the first wheel of the rear truck with the rail. The sanding is entirely independent and automatic on each car.

A decelostat valve is installed in the brake cylinder pipe between the relay valve which supplies air to the brake cylinders, and the brake cylinders themselves. Normally, the decelostat valve does not interrupt the flow of air to or the exhaust of air from the brake cylinders during brake applications and releases. When the wheels slip the decelostat valve causes a momentary release of braking pressure on the wheels involved and initiates sanding which continues after each initiation for a timed period and is automatically terminated.

They state that a very small amount of sand is used, that sliding wheels are a rarity and there has been no track circuit failure due to sand on the rail.

Another railroad reports the use of similar equipment on their streamliners, the differences being in the equipment which initiates the sanding, and provision for sanding is for one direction only.

Action Recommended

Acceptance as information.

A.A.R. SIGNAL SECTION SPECIFICATION 233-48.

VOICE PASS FILTER FOR CODED SYSTEM CONTROL

1. *Purpose.*

(a) This specification is for the purpose of providing a voice pass filter to block direct current code and for use in joining two coded control line circuits or for joining a coded control line circuit to a telephone circuit for through voice transmission only. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Filter shall be designed for indoor service.

(b) Filter shall be designed for wall and shelf mounting.

(c) Filter shall be so designed and constructed that when connected in the coded control line it shall have negligible effect on the telephone circuit.

(d) Filter shall be so designed that it will not interfere with nor cause distortion in the transmission of control and indication codes when used in the coded control system for which it is designed.

(e) Filter shall be so designed that it will effectively block direct current code and attenuate carrier frequencies in the coded control lines for which it is designed.

(f) Filter shall be so designed that it will pass voice frequencies with a loss not to exceed one decibel.

7. Coil insulation.

(a) Coils shall be wound with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(b) Coils shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171. *R-7-b.

8. Leads and terminals.

(a) Filters shall be provided with terminal boards made of molded insulation, ebony asbestos wood or other equally suitable material of thickness sufficient to prevent warping or damage in shipment. Terminal boards shall be so located as to be easily accessible.

9. Binding posts.

(a) Binding posts, nuts and washers shall conform to Drawing 1070, assembly 107010, for field wire connections.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, or soldered terminals, shall be used where no field wires are connected to such terminals.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Binding posts shall be spaced not less than 1 in. centers.

10. Name plate and diagram.

(a) A name plate shall be securely fastened to each filter and shall give the following information:

1. Manufacturer's name.
2. Type.
3. Serial number.
4. Manufacturer's reference number.

(b) Information showing the arrangement of coils, and capacitors, the binding posts to which these parts are connected and the markings identifying the binding posts, shall be shown by a diagram on a card or tag attached to each filter.

11. Case.

(a) Case shall be designed to protect the filter coils, capacitors, etc., and leads from these units to binding posts.

* Alternate requisites section.

12. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 3,000 volts a.c. between their terminals.

(d) A potential of twice the normal operating requirements at a suitable frequency shall be impressed across the windings for one minute, without any excessive flow of current indicating a short circuit.

(e) Capacitors used in the filter shall withstand across their terminals a potential of 4,000 volts d.c. for 15 seconds. Furthermore, such capacitors shall be afforded maximum protection against transient line potential by connecting them between sections of the filter reactors employed in the filter.

13. *Purchaser's order.*

(a) Purchaser's order will specify the following:

1. Full description of circuits with which filter will be used.

14. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

(e) The following test may be required by Purchaser on all filters:

1. Filters may be connected in a standard coded control circuit provided by the Manufacturer in which the coding units used in the specified system are connected to lines upon which there is a superimposed telephone circuit. An operating test with a voice pass filter connecting the lines will be made from which it will be determined that telephone transmission is satisfactorily obtained over the lines by the filter connection without affecting code operation.

15. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

16. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

17. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of containers and their contents shall be furnished for each shipment.

18. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subject to misuse, negligence or accident.

Alternate requisites.

R-7-b.

Coils shall be treated by impregnation or dipping with insulating varnish in accordance with Requisites for Varnish for Treatment of Electrical Windings, Manual Part 174.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 234-48.

VOICE AND TYPE H PASS FILTER FOR
CODED SYSTEM CONTROL1. *Purpose.*

(a) This specification is for the purpose of providing a filter to block direct current code and effectively pass voice frequencies and Type H carrier frequencies between line sections involving coded control; also to protect coded carrier control circuits employing frequencies above the Type H range against low impedance in the Type H and voice equipment. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Filter shall be designed for indoor service.

(b) Filter shall be designed for wall and shelf mounting.

(c) Filter shall be so designed and constructed that when connected in the coded control line it shall have negligible effect on the telephone and Type H carrier circuits.

(d) Filter shall be so designed that it will not interfere with nor cause distortion in the transmission of control and indication codes when used in the coded control system for which it is designed.

(e) Filter shall be so designed that it will effectively block direct current code and attenuate coded carrier control frequencies above those used in the Type H carrier system.

(f) Filter shall be so designed that it will pass voice and Type H frequencies with a loss not to exceed one decibel.

7. *Coil insulation.*

(a) Coils shall be wound with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(b) Coils shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171. *R-7-b.

8. *Leads and terminals.*

(a) Filters shall be provided with terminal boards made of molded insulation, ebony asbestos wood or other equally suitable material of thickness sufficient to prevent warping or damage in shipment. Terminal boards shall be so located as to be easily accessible.

9. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070, assembly 107010, for field wire connections.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, or soldered terminals, shall be used where no field wires are connected to such terminals.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Binding posts shall be spaced not less than 1 in. centers.

10. *Name plate and diagram.*

(a) A name plate shall be securely fastened to each filter and shall give the following information:

1. Manufacturer's name.

2. Type.

3. Serial number.

4. Manufacturer's reference number.

(b) Information showing the arrangement of coils, and capacitors, the binding posts to which these parts are connected and the markings identifying the binding posts, shall be shown by a diagram on a card or tag attached to each filter.

11. *Case.*

(a) Case shall be designed to protect the filter coils, capacitors, etc., and leads from these units to binding posts.

* Alternate requisites section.

12. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 3,000 volts a.c. between their terminals.

(d) A potential of twice the normal operating requirements at a suitable frequency shall be impressed across the windings for one minute, without any excessive flow of current indicating a short circuit.

(e) Capacitors used in the filter for connection across the code line shall withstand across their terminals a potential of 4,000 volts d.c. for 15 seconds. Furthermore, such capacitors shall be afforded maximum protection against transient line potential by connecting them between sections of the filter reactors employed in the filter.

13. *Purchaser's order.*

(a) Purchaser's order will specify the following:

1. Full description of circuits with which filter will be used.

14. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

(e) The following test may be required by Purchaser on all filters:

1. Filters may be connected in a standard coded control circuit provided by the Manufacturer. An operating test will be made from which it will be determined that the filter passes voice and Type H frequencies while attenuating coded control frequencies above those used on the Type H system without affecting code operation.

15. Inspection.

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

16. Packing.

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

17. Marking.

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of containers and their contents shall be furnished for each shipment.

18. Warranty.

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subject to misuse, negligence or accident.

Alternate requisites.**R-7-b.**

Coils shall be treated by impregnation or dipping with insulating varnish in accordance with Requisites for Varnish for Treatment of Electrical Windings, Manual Part 174.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 235-48.

VOICE AND CARRIER PASS FILTER FOR
CODED SYSTEM CONTROL1. *Purpose.*

(a) This specification is for the purpose of providing a filter to block direct current code and effectively pass frequencies in the voice range, and above, between two coded control line sections or a coded control line section and a telephone line. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Filter shall be designed for indoor service.

(b) Filter shall be designed for wall and shelf mounting.

(c) Filter shall be so designed and constructed that when connected in the coded control line it shall have negligible effect on the carrier and telephone circuits.

(d) Filter shall be so designed that it will not interfere with nor cause distortion in the transmission of control and indication codes when used in the coded control system for which it is designed.

(e) Filter shall be so designed that it will effectively block direct current code.

(f) Filter shall be so designed that it will pass voice and carrier frequencies with a loss not to exceed one decibel.

7. Coil insulation.

(a) Coils shall be wound with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(b) Coils shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171. *R-7-b.

8. Leads and terminals.

(a) Filters shall be provided with terminal boards made of molded insulation, ebony asbestos wood or other equally suitable material of thickness sufficient to prevent warping or damage in shipment. Terminal boards shall be so located as to be easily accessible.

9. Binding posts.

(a) Binding posts, nuts and washers shall conform to Drawing 1070, assembly 107010, for field wire connections.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, or soldered terminals, shall be used where no field wires are connected to such terminals.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Binding posts shall be spaced not less than 1 in. centers.

10. Name plate and diagram.

(a) A name plate shall be securely fastened to each filter and shall give the following information:

1. Manufacturer's name.

2. Type.

3. Serial number.

4. Manufacturer's reference number.

(b) Information showing the arrangement of coils, and capacitors, the binding posts to which these parts are connected and the markings identifying the binding posts, shall be shown by a diagram on a card or tag attached to each filter.

11. Case.

(a) Case shall be designed to protect the filter coils, capacitors, etc., and leads from these units to binding posts.

* Alternate requisites section.

12. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 3,000 volts a.c. between their terminals.

(d) A potential of twice the normal operating requirements at a suitable frequency shall be impressed across the windings for one minute, without any excessive flow of current indicating a short circuit.

(e) Capacitors used in the filter shall withstand across their terminals a potential of 4,000 volts d.c. for 15 seconds. Furthermore, such capacitors shall be afforded maximum protection against transient line potential by connecting them between sections of the coils employed in the filter.

13. *Purchaser's order.*

(a) Purchaser's order will specify the following:

1. Full description of circuits with which filter will be used.

14. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

(e) The following test may be required by Purchaser on all filters:

1. Filters may be connected in a standard coded control circuit provided by Manufacturer so that an operating test may be made from which it can be determined that the filter satisfactorily passes voice and carrier frequencies and that it does not adversely affect the telephone, carrier, and coded circuits.

15. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

15. *Inspection.*—Continued.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

16. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

17. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of containers and their contents shall be furnished for each shipment.

18. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subject to misuse, negligence or accident.

Alternate requisites.

R-7-b.

Coils shall be treated by impregnation or dipping with insulating varnish in accordance with Requisites for Varnish for Treatment of Electrical Windings, Manual Part 174.

Action Recommended

Acceptance for submission to letter ballot.

AUTOMATIC BLOCK SIGNALS WITH SUPERIMPOSED
CONTROL ON THE CHICAGO, MILWAUKEE,
ST. PAUL & PACIFIC R.R.*

The Chicago, Milwaukee, St. Paul & Pacific R.R. has installed a system, termed controlled automatic block, on a complete engine district of 98 miles of single track between Aberdeen, S. Dak. and Mobridge, S. Dak., which was formerly manual block territory. Following this installation, the controlled automatic block system was extended between Mobridge, S. Dak. and Hettlinger, N. Dak., 122.5 miles, and between Rhame and Marmarth, N. Dak., 14.5 miles. In most of the essential details the signaling and train operation are the same as on the earlier installation, which is described below.

In brief, the new installation is controlled automatically by track circuits throughout on all main track, and, in addition, the signals at the sidings are manually controlled from the dispatcher's office, so that train movements are authorized by signal indication. With the exception of one siding and one yard lead switch where power machines were installed, and one siding switch equipped with a spring switch mechanism, the main-track switches are operated by hand throw stands the same as previously.

The number of trains operated daily is a minimum of 14 and a maximum of 25, including six passenger trains, two time freight trains each way, a local freight train and extra trains as required.

Between Aberdeen and Mobridge the line crosses rolling prairie. From Aberdeen to milepost 66 the grade is very light, ascending gradually. The curvature is very slight with long section of tangent, 7 to 10 miles in length. West from milepost 66 to Mobridge there are a number of curves, none exceeding 1 degree, and the grade is descending at a maximum of 0.5 per cent.

Extensive track changes have been carried out to reduce the curvature to a maximum of 1 degree, new 112 lb. rail, new ties and ballast have been installed.

All the above improvements make it practicable to operate trains at high speeds.

Sidings are located at 12 stations with a capacity of from 83 to 112 cars. These stations are from 5.3 to 8.6 miles apart. All of the switches at these sidings are operated by hand throw stands. There are also a number of house tracks operated by hand throw switch stands.

At Glenham the realignment by-passed the station and the old track, capacity 155 cars, was left in place for use by local trains and others as desirable. These switches are power-operated.

At each siding switch there are three signals. One governing movements over the facing switch has a top unit, Red, Yellow or Green, and a second unit, called an "S" unit. This "S" unit consists of a cast-iron case, a reflector, a lamp and a clear glass roundel 10 inches in diameter. The lamp is normally extinguished but when lighted shows a black letter "S" on a white background. A leaving signal for main track, top unit may display Red, Yellow or Green, second unit a fixed Red and a dwarf signal for siding which may display Red, Yellow or Green. This dwarf signal has an "S" unit mounted below. These signals are located at siding clearance.

* *Railway Signaling*, April 1947, p. 229.

At house and industrial tracks connected with main track there is a dwarf signal with "S" unit below, which governs movements from the side track to main track.

The general arrangement of signals between sidings is to have one intermediate signal in each direction. These signals are located approximately 10,000 feet from the head-in signal. Where the distance between sidings is not more than 4.5 miles intermediate signals are located opposite.

This arrangement of signals is entirely practical where the maximum number of trains is not too large and where close spacing of following trains is not necessary.

All of the signals are controlled from a machine in the dispatcher's office at Aberdeen. This machine has an illuminated track diagram which shows the presence of a train in all main-track sections and there is automatic graphic train chart with pens to record the passing of trains at all "OS" points. There is a three-position signal lever for signals and a switch lever for each passing siding switch. There is also a toggle switch below, which is used to indicate by a red light that a siding is occupied. Signals governing from house and industry tracks are controlled by special push-to-turn buttons mounted near the bottom of panel. When a signal is cleared for entrance to main track if the train is to proceed west the button is turned to the left and if to proceed east it is turned to the right.

Normally de-energized track circuits are used, maximum length 10,200 feet. These circuits may operate at either 75 or 180 code and are used for approach or clear aspect respectively.

Each coded track circuit has a track relay and battery at each end of the circuit and is so arranged that the battery feed is always on the leaving end of the circuit.

Switch levers are used with the hand-operated switches in connection with code selections for control of signals and lights show when the switch is normal or reverse. There are no track circuits on sidings but the machine circuits are arranged to prevent sending out controls for opposing movements into sidings at the same time.

When a control is sent out for a train to enter a siding the entering signal will display Red over "S" and the approach signal will display Yellow. When the train arrives the trainman will throw the switch and the train will enter the siding.

When a train is to leave a siding a control is sent out which lights the "S" under the Red and this authorizes the trainman to throw the switch, after which the signal will display either Yellow or Green, provided track is clear.

When a train is ready to leave a house or industry track, the conductor telephones the dispatcher. When he is ready for the train to leave, he informs the conductor and sends a control to that station. The conductor pushes a button which causes the letter "S" to be displayed under the Red in the dwarf signal. This authorizes the trainman to throw the switch, and derail where used, and Yellow will then be displayed, provided track is clear.

The code line controls and indications are superimposed on the existing telephone train dispatcher circuit. This consists of a pair of No. 9 bare hard-drawn copper wires which also carry telegraph carrier and voice carrier for phone circuit between Chicago and Seattle.

A telephone is located at each switch and at other locations near stations. On each telephone there is a double-pole, double-throw switch by means of which the phone can be connected to either the dispatcher's circuit or to a separate block circuit. This block line can be used to patch the dispatcher's circuit, patching connections being provided at each station.

At towns where commercial power is available, a 220 volt a.c. circuit is extended out to the signal equipment housing at each of the siding switches. This power feeds through transformers to supply the signal lamps, and, through rectifiers, to charge eight cells of 160 ampere-hour lead storage battery. The eight cells as a whole feed the line code equipment, and five of these cells energize the local circuits and act as stand-by for the signal lamps in case of a power outage.

At the sidings where no commercial a.c. power is available, a wind-driven d.c. generator was installed to charge storage batteries. At these locations, the signal lamps are fed from the storage battery, and are on approach lighting control, this requiring track circuits about 500 feet long on the siding in approach to the leave siding signals. At these siding switch locations where wind generators are in service, there are two sets of 160 ampere-hour lead storage battery, one set of 8 cells to feed the line code equipment and one set of 5 cells to feed the signal lamps and local circuits.

The advantages of this installation are:

1. All train movements are authorized by signal indication superseding timetable and train order operation.
2. Increases safety of train operation and expedites train movements.
3. The number of intermediate signals is kept to a minimum.
4. Line wire is reduced to a minimum.
5. Normally de-energized track circuits and approach lighting of signals eliminate the necessity of a complete power supply line.

Action Recommended

Acceptance as information.

A.A.R. SIGNAL SECTION SPECIFICATION 229-48.

SELENIUM RECTIFIERS

1. *Purpose.*

(a) The purpose of this specification is to provide selenium rectifiers for battery charging, direct operation of direct current appliances from an alternating current source of power, or as a valve in suppressing arcs formed at contacts, in prolonging the release period of direct current electromagnetic apparatus, as a snubber or for similar purposes in railway signaling. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

(b) When requested by the Purchaser, the Manufacturer shall submit a statement of efficiency along with the tender showing the efficiency at one-fourth, one-half, three-fourth and full load.

3. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

4. *Binding posts.*

(a) Binding posts shall conform to Drawing 1070 or 1078. The thread shall be 14-24 for external connections. The assembly for external connections shall conform to detail 107010.

(b) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(c) Binding posts shall be spaced not less than 1 in. centers.

5. *Design.*

(a) Rectifier shall be of a design approved by the Purchaser.

(b) The rectifying portion of the rectifier shall consist of one or more selenium cells, which have stable rectifying junctions. Only rectifying junctions whose characteristics are known and are stable so as to give extremely long rectifier life, are to be used. A selenium rectifier cell shall consist of a metal back plate of aluminum, steel or other suitable material which is coated with a layer of selenium. The front electrode shall be a low melting alloy applied to the selenium layer. The rectifying junction is formed between the selenium and the front electrode.

(c) Forward and reverse resistance characteristics shall be equal to or better than that shown in Fig. 1.

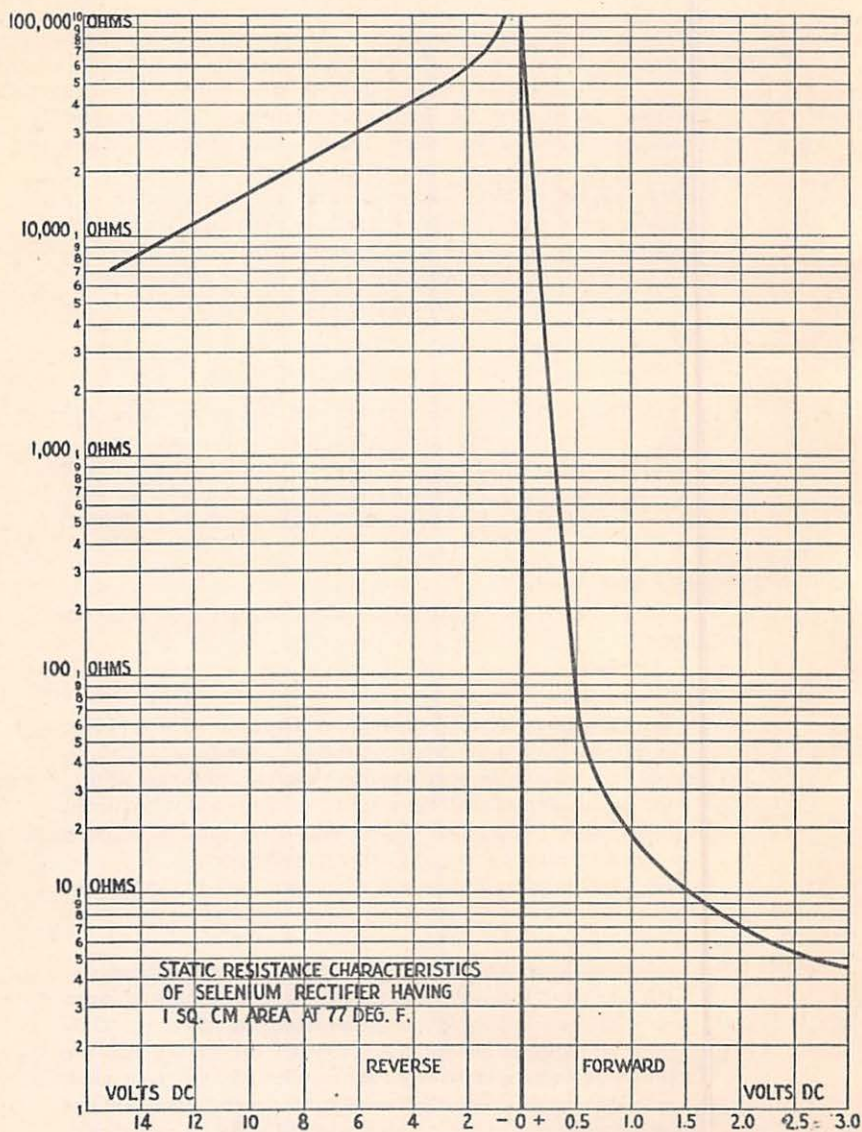


FIG. 1

5. *Design.*—Continued.

(d) Unless otherwise specified, the rectifying portion of battery chargers and direct operation rectifiers shall be of the full-wave type.

(e) Unless otherwise specified, selenium rectifier cells used as valves shall be connected the same as half-wave rectifiers.

(f) Selenium rectifier stacks shall be protected against atmospheric conditions encountered in signal cases, viz., moisture, mild acid fumes, salt atmosphere, etc., by a suitable finish coating. A protective housing shall be supplied over rectifier stack or stacks in complete units.

(g) Terminal markings for a.c. and d.c. terminals shall be plain and permanent.

(h) Battery charging rectifiers shall be provided with means for limiting and adjusting the output, and securely holding the movable parts in position after adjustment is made. No change in adjustment of rectifier output shall occur when locking device is locked. When specified, rectifiers for direct operation shall have means for adjusting output voltage.

(i) The limiting device on battery charging rectifiers shall be so designed that if energized from rated frequency and voltage the rectifier cannot be grossly overloaded when feeding into a battery whose nominal voltage is the maximum rated d.c. voltage for the rectifier. The adjusting device shall be designed so that the output current of the rectifier can be adjusted to within 5 per cent of any desired value within the range from maximum obtainable output to minimum obtainable output. The maximum obtainable output shall be at least 180 per cent of the maximum rated output.

(j) When a transformer is furnished as a component part of the rectifier its assembly shall be in accordance with Specification 83, Manual Part 164.

(k) When a reactor is furnished as a component part of the rectifier assembly it shall be in accordance with Specification 104, Manual Part 121.

(l) When a resistor is furnished as a component part of the rectifier assembly it shall be in accordance with Specification 106, Manual Part 135.

6. *Rating.*

(a) The rating of rectifiers designed for use inside buildings shall be based on continuous operation in freely circulating air whose temperature does not exceed 120 deg. F.

(b) The rating of rectifiers designed for use in relay boxes, metal housings, etc., shall be based on continuous operation in freely circulating air whose temperature does not exceed 160 deg. F.

7. *Dielectric requirements.*

(a) Unless otherwise specified, electrical apparatus assembled shall withstand for one minute an insulation test, at place of

7. *Dielectric requirements.*—Continued.

manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom. When rectifiers are given the insulation test, care must be taken to short circuit all terminals, both a.c. and d.c., with one jumper before the 3,000 volts are applied. This precaution is necessary when testing this type of apparatus because the a.c. and d.c. terminals are not insulated from one another.

(b) A surface leakage distance of not less than $\frac{3}{8}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

8. *Tests.*

(a) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(b) Rectifiers and valves, before shipment to Purchaser, may be subjected to the tests described in the following sections.

(c) Tests shall be made at room temperature of approximately 77 deg. F. unless otherwise specified.

(d) Output test.

1. Rectifier output shall be measured with d.c. voltmeter and d.c. ammeter of the permanent magnet type.

2. Rectifier shall be operated at rated full load for at least 1 hour before readings are taken. Under this condition the rectifier must deliver output in accordance with Manufacturer's rating for the rectifier.

(e) Temperature rise test.

1. Tests for temperature rise shall be made on rectifiers of new design as type tests only. Rectifiers shall be operated for 2 hours in the maximum ambient temperature specified for the rectifier before temperature readings are taken. These readings shall be taken on the hottest stack and the hottest cell in the stack. Temperature readings shall be made on a thermo-couple instrument or other suitable means to give accurate indication of cell temperature. Maximum cell temperature shall not exceed 185 deg. F. or as specified by the Manufacturer.

(f) Back leak tests.

1. Before a.c. power is applied and immediately after connecting a test voltage of the maximum rated d.c. potential across the d.c. terminals the leakage current shall not exceed 1.5 per cent of the 120 deg. F. current rating nor 1 per cent of the 160 deg. F. current rating of the rectifier.

(g) Valve test.

1. The first four rectifiers of a given design for use as valves shall be tested to insure that they will perform the function for which designed, and their forward and reverse resistances and temperature rise, at current and voltage values specified, recorded. Additional valves of same design

8. *Tests.*—Continued.

will be tested for forward and reverse resistance and such valves must meet the standards set by service test.

2. Additional service tests may be made at the option of the Manufacturer and new resistance requirements established.

(h) Efficiency test.

1. Efficiency tests when required shall be made as follows:

$$\text{Efficiency} = \frac{\text{Watts output}}{\text{Watts input}}$$

The a.c. watts input to be measured by dynamometer type wattmeter or a suitable equivalent. The d.c. watts output to be measured by d.c. voltmeter and d.c. ammeter of the permanent magnet type.

9. *Name plate and instructions.*

(a) A name plate shall be securely fastened to each rectifier and shall give that part of the following information which applies to the particular rectifier being furnished:

1. Name and address of Manufacturer.
2. Rated a.c. voltage.
3. Rated frequency.
4. Maximum rated d.c. volts.
5. Maximum rated d.c. amperes.
6. Serial number.
7. Manufacturer's reference number.
8. Service (intermittent or continuous).

(b) An instruction tag shall be attached to each rectifier giving such general information and instructions, including wiring diagram, as the Purchaser may need to install and adjust the rectifier.

10. *Inspection.*

(a) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(b) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(c) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

11. *Purchaser's order requirements.*

(a) Purchaser's order shall specify the following:

1. Purchaser's drawing or other reference.
2. Nominal a.c. volts, frequency cycles,
max. d.c. volts, max. d.c. amperes

11. *Purchaser's order requirements.*—Continued.

3. Number of cells and type of battery to be charged

4. Character of load or proposed use

5. Any special requirements shall be clearly stated.

12. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

13. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

14. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subject to misuse, negligence or accident.

Action Recommended

Acceptance for submission to letter ballot.

GROUNDING OF SIGNAL POWER SUPPLY TRANSFORMERS

The purpose of grounding signal power transformers is to provide protection for personnel and transformers. By establishing exposed metal parts of signal power transformers at or near earth potential these protective grounds prevent personal injury from electrical shock when transformer insulation faults occur. Also when transformer case ground is interconnected to lightning arrester ground reduced voltages are impressed upon transformer insulation during lightning surges.

In the case of an internal transformer winding grounded to the transformer case, or leakage from internal winding to case, the grounded case and its connection to ground may be required to dissipate considerable current in order to prevent potential of the transformer case from rising above the potential of the ground. The greatest degree of effectiveness of this protection requires low resistance grounds.

The 1947 National Electrical Safety Code (NEC 4214) requires transformer cases to be grounded where transformers are operated on circuits at more than 150 volts to ground, and (NEC 7153) requires cases of transformers operating at more than 600 volts to be grounded.

Made grounds should be installed and maintained in accordance with Signal Section Manual Parts 92 and 61, which require that ground conductor be not less than No. 6 A.W.G. soft-drawn copper wire for mechanical reasons, and the ground resistance be not more than 15 ohms. In addition to grounding transformer cases, as a safety measure, before working on signal supply transformers of more than 150 volts to ground, the transformer should be disconnected from primary and secondary circuits.

Action Recommended

Acceptance as information.

COOPERATIVE REPORT

AMERICAN PETROLEUM INSTITUTE
CORRELATING COMMITTEE ON CATHODIC PROTECTIONR. B. Amsden, Representative
G. P. Neal, Alternate

The organization and purposes of the Correlating Committee on Cathodic Protection, consisting of representatives of eleven nationwide industry associations and communication companies and sponsored by the American Petroleum Institute were outlined in the Signal Section 1947 Annual Meeting Advance Notice*.

At a meeting held at the William Penn Hotel in Pittsburgh, Pa., on December 11 and 12, 1947, the Committee reviewed and progressed the work of the four subcommittees which are preparing a series of bulletins to promote better understanding of the modern technique of cathodic protection against corrosion of water, gas and oil pipes, communication, signal and power cables, rail tracks, tanks, equipment foundations and other metallic structures buried or in contact with the soil or water.

Bulletin 1, in part, is reproduced on pages 155 to 157, inclusive, for the information of members of the Signal Section. It is written in layman's language and shows that it is good business for managements to be generally informed about the subject and to give sympathetic support to their engineers dealing with the application of cathodic protection on the basis of mutual appreciation of the equities and benefits involved.

Bulletin 2 when completed, will define a practical procedure for inter-operator notification in which the railroads will be especially concerned in connection with avoiding possible interference with signal operation. Bulletin 3 will contain information concerning the technical aspects of cathodic protection coordination and Bulletin 4 will treat with joint systems. The Committee will refrain from dealing with individual local problems which may develop.

Action Recommended

Acceptance as information.

* A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, p. 164-A.

Management Information
on
CATHODIC PROTECTION
OF BURIED METALLIC STRUCTURES AGAINST CORROSION

Bulletin 1 prepared by
Correlating Committee on Cathodic Protection

Corrosion of buried plant and its contingent losses are costing American industry about a billion dollars per year. Much of this loss can be stopped by proper preventive measures.

These enormous losses and the problems of preventing them are shared in different form and degree by all operators of water, gas and oil lines, communications, signal and power cables, rail tracks, tanks, equipment foundations and other metallic structures buried or in contact with the soil or water.

Corrosion of buried structures is simply a chemical attack by Nature which attempts to revert refined metals to their original form as ores or compounds. This chemical attack always goes hand-in-hand with a flow of electric current from the metal. In most cases a chemical attack causes the current flow but, conversely, a flow of impressed current from metal into soil causes chemical attack. If such current out-flow can be prevented, corrosion cannot occur.

Regardless of whether the attack initiates the current flow or vice versa, the corrosion damage is physically similar; and a current out-flow of one ampere in one year accompanies a loss of as much as 20 lb. of iron or steel, or 70 lb. of lead.

Corrosion prevention properly starts with the design of structures and equipment, including the selection and placement of materials—in particular avoiding the contact of dissimilar metals—so as to minimize corrosion possibilities. During plant construction and subsequent operation, much corrosion can be prevented by avoiding the disposal of waste matter where it may unnecessarily pollute the soil in or near the plant. In concentrated operating areas, effective surface drainage will minimize the likelihood of soil pollution.

The attention of industry was directed, even before 1900, to the corrosion of buried pipe and cable near electrified street-railway tracks by the currents which "strayed" into these structures from the rails. The pipes and cables were corroded where these currents left them via the soil enroute back to the current source. This type of corrosion is called "electrolysis."

Joint engineering committees in many metropolitan areas, through a fine spirit of cooperation, have effectively minimized the damage due to stray-current electrolysis. The customary technique is to keep the stray currents as low as possible, and to provide continuous metallic paths through which they will flow back to their source.

Though not initially recognized as beneficial, these currents, when strong enough, stopped corrosion where they strayed into the other structures because they prevented the out-flow of the weaker currents attending such corrosion. This electrical counteraction is the basis of the rapidly developing technique of cathodic protection.

In numerous areas where transit companies have abandoned electrified track, operators of other structures are finding that the removal of the stray railway currents has allowed the weaker currents of natural corrosion to flow unopposed. The cathodic protection before provided in various degrees by the stray currents has been removed!

Outside of the geographically small metropolitan areas, different problems are presented. Corrosion of buried structures is widespread unless it is prevented. Among the accepted preventive techniques are properly engineered coatings or cathodic protection, or a combination of the two.

If a structure could be coated with an impervious and durable layer of electric insulating material, all flow of current to or from the soil would be prevented. Inasmuch as the soil and moisture would be separated from the structure, corrosion could not occur.

Although excellent coatings now are available that will provide reasonable protection if carefully applied, most of them will deteriorate or become damaged in time. Such coating defects tend to focus corrosive action and hasten structure damage locally.

Early structures were buried bare, and many coatings applied on other structures prior to the last decade have little if any protective value now. To coat or recoat these operating structures—which usually requires that they be uncovered, raised and cleaned—is difficult and expensive, and often impractical.

For reducing corrosion on older structures, or insuring continued protection with newer coatings, the use of cathodic protection is indicated. Specifically, this is the technique of impressing inward-flowing currents to counteract, and thus prevent, the outward-flowing currents of natural corrosion. Where cathodic protection is applicable, it has the special advantage that it can be installed with very little disturbance of the structures.

To apply cathodic protection requires continuous supplies of protective current. It requires also, to be buried in suitable groundbeds at appropriate distances from the structure, one or more masses of metal or carbon (called "anodes") through which this current can be introduced into the soil. For this current to serve its purpose as it fans out through the soil and distributes itself along the structure, it must be of sufficient strength or density to enter the structure and counteract the harmful corrosion currents.

Two types of protective current source may be used. Where considerable current is required, it may be obtained from direct current generators or rectifiers connected by insulated wires positively to the anodes and negatively to the structure. For the introduction of external currents through the soil into the structure, anodes of graphite rod, or of scrap cast-iron or steel are customarily used.

Where less protective current will suffice, anodes can be used which will self-generate the needed current. When masses of magnesium, aluminum or zinc are buried and connected to a steel or lead structure by insulated wires, they will generate current (as in a battery) which will flow through the soil into the structure.

All types of anodes will be corroded by the protective current which they discharge to the soil, and they must be renewed at intervals. However, under favorable conditions these anodes may last several years before replacement is necessary.

Some of the current introduced at the anodes to cathodically protect one structure may enter a neighboring structure and traverse it for a distance while enroute to the protected one. Where this current leaves the neighboring structure and enters the soil, corrosion occurs which is similar to street-railway stray-current electrolysis. It can be prevented in several ways, one of the commonest of which is to connect the neighboring structure to the protected one by a wire "drainage bond" of proper resistance.

Because of this possibility of interaction, any operator planning a cathodic protection installation should notify operators of neighboring buried structures so that all concerned can appraise the interaction problems. Experience shows that these can be dealt with most effectively and satisfactorily through co-operative study and tests by the engineers of the operators involved.

The foregoing paragraph applies to conditions where cathodic protection is designed primarily for the structure (or structures) of a single operator. Frequently, however, where reasonably adjacent structures of two (or more) operators are subject to similar corrosion damage, "joint cathodic protection systems" can be designed, installed and operated economically to the benefit and satisfaction of all concerned.

The fundamentals of cathodic protection are relatively simple, but solution of its technical and economic problems requires a high degree of engineering skill. The harmony in which metropolitan engineers have coordinated their complex electrolysis problems sets the pattern for the cooperation needed to deal with local cathodic protection problems in the field. These call for a business judgment by all concerned, and an approach based on mutual appreciation of the obvious equities and resultant benefits.

The use of cathodic protection offers widespread opportunities for reducing the enormous losses incident to underground corrosion, and its application requires cordial intercompany relations. Thus it is good business for all managers of buried plant to be generally informed about, and to give sympathetic support to their engineers dealing with, the application of cathodic protection.

Mileages of Buried Structures in The United States (According to best available estimates)

Pipe.....		988,000 mi.
Gas lines.....	321,000 mi.	
Natural gas.....	228,500 mi.	
Manufactured gas.....	71,200	
Mixed gas.....	18,500	
Liquefied petroleum gas..	2,800	
Water lines.....	250,000	
Oil lines.....	150,000	
Crude oil.....	133,500	
Products.....	16,500	
Miscellaneous oil country pipe.....	267,000*	
Steel track.....		425,000
Railroads.....	406,500	
Transit lines.....	18,500	
Metal-sheathed cable.....		167,000
Communications and signal systems.....	92,000	
Electric power distribution.....	75,000	
Total.....		1,580,000 mi.

* This figure is based on a 17.5 per cent sampling of field operations.

COMMITTEE V—CONTRACTS AND INSTRUCTIONS

Personnel

C. D. Cronk, Chairman	
G. A. Washburn, Vice-Chairman	
G. T. Callahan	G. R. Pflasterer
B. F. Dickinson	E. B. Platt
R. C. Dueland	E. L. Rogers
A. C. Eastman	O. W. Rost
O. Falkenstein	G. C. Schindler
W. A. Hough	W. L. Scott
A. Hunot	S. P. Searle
F. M. Kunker	A. L. Shepard
J. C. Patterson	W. H. Stilwell
E. S. Taylor	

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Installation, maintenance and testing instructions, collaborating with other committees concerned.
 - (a) Instructions for testing signal installations before placing in service.
 - (b) Instructions for testing electronic tubes.
4. Definitions for technical terms used in signaling.
5. Forms for reporting progress of the component parts of new signal installations and expenditures for labor.
6. Investigate and report on a simplified system of numbering and identification of wires and circuits which does not require the changing of nomenclature and tags on wayside circuits when a minor change is made.
7. Investigate and report on the use of portable induction type telephones by signal forces.

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Definitions for Technical Terms Used in Signaling, Manual Part 55.
Revision of Instructions for Alternating Current Track Circuits, Manual Part 162.
Revision of Instructions for Storage Batteries, Manual Part 14.
Revision of Instructions for Electric Locks for Interlocking Machines, Manual Part 23.
Revision of Instructions for Automatic Block Signaling Systems, Manual Part 102.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 17, 1948.

Revision of Instructions for Switch Circuit Controllers, Manual Part 134.
Revision of Instructions for Automatic Highway Grade Crossing Protective Systems, Manual Part 150.

Revision of Instructions for Facing Point Locks Applied to Spring Switches, Manual Part 159.

Revision of A.A.R. Sig. Sec. 1673B and 1674C.

3. (b) Instructions for Electronic Tubes.

Disposition of 1947 Letter Ballot Subjects

The following subjects presented by this Committee in the 1947 Annual Meeting Advance Notice were submitted to letter ballot and officially approved:

Definitions for Technical Terms Used in Signaling—Now in Manual Part 55.

Instructions for Alternating Current Relays—Now in Manual Part 124.

Instructions for Light and Motor Semaphore Signals—Now in Manual Part 54.

A.A.R. Sig. Sec. 1662C—Graphical Symbols—Tracks and Highway Crossings
—Now in Drawing Section of Manual.

Instructions for Movable Bridge Protected by Signals—Now in Manual Part 233.

Instructions for Maintaining Reflector Signs—Now in Manual Part 234.

(Revision of Definitions for Technical Terms Used in Signaling)
A.A.R. SIGNAL SECTION DEFINITIONS.

TECHNICAL TERMS USED IN SIGNALING

1948

Auto-manual. (New)

See definition for Signal, Semi-automatic.

Control, Auto-manual. (New)

See definition for Control, Semi-automatic.

Control, Semi-automatic. (New)

A control which is operated both manually and automatically.

Lever, Check. (New)

See definition for Lever, Traffic.

Lever, Crossing. (New)

See definition for Lever, Traffic.

Lever, Detector. (New)

See definition for Lever, Traffic.

Lever, Route. (New)

See definition for Lever, Traffic.

Lever, Traffic. (Revision)

A lever, or equivalent controlling device, used as a check lever, crossing lever, detector lever, master lever, route lever, also to control another lever, group of levers or functions to establish traffic direction by signal indication.

Resistance, Train Shunt. (New)

The actual resistance in ohms from rail to rail through wheels and axles of a train, engine or car. This resistance will vary with rail and wheel surface conditions and with weight of equipment.

Shunting Sensitivity. (New)

Shunting sensitivity of a track circuit is:

1. Non-coded track circuit.

The maximum resistance in ohms which will cause the relay contacts to open when this resistance is placed between the rails at the most adverse shunting location.

2. Coded track circuit.

The maximum resistance in ohms which will prevent the code responsive track relay from following the code when this resistance is placed between the rails at the most adverse shunting location.

Target, Switch. (Revision)

A device mechanically actuated by a switch stand, or a switch point, to indicate the position of the switch.

Target, Switch; Reflector Type. (New)

A switch target equipped with reflector units in order that it may display indications by night.

Action Recommended

Acceptance for submission to letter ballot.

(Revision of Instructions for Alternating Current Track Circuits)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

NON-CODED ALTERNATING CURRENT TRACK CIRCUITS

1948

Adjustments.

1. The adjustment of alternating current track circuits depends on many factors, such as the type of track circuit; whether double or single rail with steam or electric traction; the length of the track circuit; the ballast condition; the desired shunting values at both relay and transformer ends of the track circuit; the type of relay; and the weight of train equipment.

2. When making train shunt resistance test it should be made in accordance with Form 7003, Manual Part 196.

3. For single-element relays, the voltage at the relay track terminals under wet ballast or other adverse conditions must be at least 10 per cent higher than the values given on the manufacturer's tag or name plate to take care of varying ballast and bonding. For two-element relays, the voltage on the relay track terminals under wet ballast or other adverse conditions should be 10 per cent higher than that necessary to energize the relay with normal front contact compression. On account of varying phase angle conditions the necessary voltage on the track element may be considerably in excess of the values marked on the manufacturer's tag or name plate. A check for the proper voltage to be applied across the track terminals of a relay under wet or other unfavorable conditions, is to shunt the relay so that its contacts open half way, then remove the shunt, and if the contacts come up to the front stop, sufficient energy is passing through the track windings.

4. Voltage at the relay local terminals must be as near as possible the normal voltage given on the manufacturer's tag or name plate. If less than the normal voltage value is impressed across the local terminals, more energy will have to be used in the track element to cause proper operation, except for centrifugal frequency relays. While a reduction in the local voltage of a centrifugal frequency relay generally does not require additional energy to the track element, this reduction in the local voltage should be avoided as it tends to increase the time of shunting.

5. When shunting two-element track relays, shunt must be applied at the terminals of the track element and not the local element.

6. On steam road track circuits the voltage on the rails at transformer end should be not more than one-half that at the transformer secondary under the worst track conditions. Where reactive transformers are in use, the voltage on the rails at transformer end should be not more than one-half the open-circuit transformer secondary voltage.

7. On electric road track circuits to obtain adequate broken-rail protection it may be necessary to make adjustments so that under worst track conditions the voltage at the rails opposite the transformer is two-thirds that of the transformer secondary. Where reactive transformers are in use the voltage on the rails at transformer end should be not more than two-thirds the open-circuit transformer secondary voltage.

Phase angle measurement.

8. To obtain the best operation of two-element track relays under adverse ballast conditions, phase measuring instruments should be used to determine that the phase angle relations in the relay approach the ideal value. These measurements may indicate that adjustments should be made to improve phase relations.

Circuit controllers.

9. Switch circuit controllers must be maintained and tested in accordance with Instructions for Switch Circuit Controllers, Manual Part 134.

Ballast resistance and rail impedance.

10. Ballast resistance should be kept as high as possible by keeping ballast free from rail and rail fastenings and providing proper drainage. Broken track spikes must not be driven through the ties.

11. Bonding must be installed and maintained in condition to insure low resistance. Bolts in angle bars should be kept tight.

12. Alternating current track circuit tests must be made in accordance with A.C. Track Circuit Characteristics, Manual Part 161.

13. Resistance of rails and bonding per 1,000 feet of track shall not exceed the assigned value for the particular type of bonding employed.

14. Resistance of ballast per 1,000 feet of track should preferably be not less than 2 ohms when wet.

Bonding and track circuit connections.

15. Bonding and track circuit connections must be inspected as instructed and renewed when necessary.

16. Switch frogs must be so bonded that when removed, track circuit will be opened.

17. When fastening shunt wires or track circuit connections care must be taken so that staples do not ground the circuit. The staples and wires must be kept in place and in good condition.

18. Fouling circuits must be so maintained as to avoid breaks or undue resistance.

Cross-bonding and bonding on electric propulsion roads.

19. To obtain broken rail detection, it is desirable that cross-bonds between neutral connections of impedance bonds on parallel tracks or between a neutral connection and a negative propulsion return cable should not be located closer than at alternate impedance bond locations. Calculations should be made and checked by field tests under the most adverse conditions so that the cross-bonding as installed does not interfere with the desired broken rail detection.

20. Both rails of a double-rail track circuit should be equally well bonded because defective bonding in one rail will cause an unbalanced condition of the track circuit due to unequal amounts of return propulsion current in the two rails.

(a) With direct current propulsion and double-rail track circuits, unbalanced propulsion current may saturate the iron core of the impedance bonds. This may lower the bond impedance to such a point that the track relay may be shunted.

Cross-bonding and bonding on electric propulsion roads.—Continued.

(b) With alternating current propulsion and double-rail track circuits, unbalanced propulsion current will cause the impedance bond to act as an auto-transformer. Since the track relay is connected in multiple with the bond the auto-transformer voltage may cause sufficient alternating current of propulsion frequency to flow in the relay to cause it to open its contacts, or to blow the protective fuse.

Insulated rail joints.

21. Insulated rail joints must be maintained and tested in accordance with Instructions for Insulated Rail Joints, Manual Part 133.

Broken-down insulated rail joint protection.

22. Where two-element track relays are used, polarities of adjacent track circuits must be staggered when the signals are in the clear position.

Resistors.

23. Where single-rail track circuits are used on electric roads, care must be taken to adjust the resistors at the relay and transformer ends so that the amount of propulsion current permitted to flow through the relay track winding is less than the allowable amount specified for a given relay. Where heavy direct current propulsion is present, a shielding or a balancing impedance may also be installed in connection with the track relay to protect against direct current in the relay windings.

Reactor.

24. The current limiting device used in the transformer track lead should be a reactor if possible, as the losses in a reactor are less than in a resistor. A resistor in place of a reactor should be used only when required to give correct phase relations in two-element track relays or to protect the relay and transformer from propulsion return current.

Fuses.

25. Fuses must be inspected as instructed and replaced in kind when necessary.

Relays.

26. Relays must be maintained and tested in accordance with Instructions for Alternating Current Relays, Manual Part 124.

Testing.

27. In testing alternating current track circuits, it is not possible to obtain the relay current by simply inserting an ammeter between the relay and track since the resistance of alternating current ammeters is so high that they considerably reduce the current to the relay when thus inserted. To measure the current the relay is receiving from the track circuit, measure first the voltage across the relay track terminals, then insert the ammeter in the track leads and again measure the terminal voltage. This voltage divided by the current gives the impedance of the relay which corresponds to the resistance of a direct current relay. Divide the relay terminal voltage, read with the ammeter removed, by the impedance, and the relay current will be obtained.

28. Ground resistance test must be made in accordance with Instructions for Resistance of Made Grounds, Manual Part 61.

Shunting sensitivity.

29. Shunting sensitivity test of a track circuit is made by determining the maximum resistance that can be placed across the rails opposite the relay and opposite the transformer to cause the relay contacts to open. If this resistance is less than 0.06 ohm, corrective measures must be taken at once. (15 feet of No. 16 A.W.G. copper wire has a resistance of 0.06 ohm.)

30. Shunting tests must be made as follows:

(a) Turnouts: Switch point side of insulated joints in lead rails and at each end of fouling circuit.

(b) Crossovers: Switch point side of insulated joints in lead rails and both sides of insulated joints at center of crossover. Where center insulated joints are not used, make test as specified in Instruction 30-a.

31. Shunting tests must be made during dry weather conditions when the maximum current is flowing through the relay coils.

32. Top of rails should be kept free from sand, rust, and other foreign matter that affects proper shunting of track circuit.

33. If the shunting sensitivity of a track circuit is lower than that of similar track circuits, check against the following possible causes:

(a) Improper amount of limiting impedance or resistance between transformer and track or between track and relay.

(b) Excess energization of the relay under minimum ballast resistance.

(c) Defective or sluggish relay.

General.

34. When track or other conditions are such that they may cause signal interruption or unsatisfactory operation of signal apparatus, the person immediately responsible must be requested to correct the condition. If such request is not acted upon within a reasonable time the matter must be reported to proper authority in writing.

35. Wire and cable must be maintained and handled in accordance with Instructions for Wire and Cable, Manual Part 190.

36. Lightning arresters must be properly connected and maintained.

37. Pipe lines under rail must clear base of rail at least $\frac{1}{2}$ inch.

38. If a track circuit fails to operate properly, check for the following possible causes:

(a) Broken rail.

(b) Loose connections.

(c) Defects in bonding.

(d) Defects in insulated rail joints.

(e) Defects in switch rod, gage-plate or pipe-line insulation.

(f) Low ballast resistance.

39. Experiments or changes must not be made in track circuits except by permission of proper authority.

40. Any unusual occurrences or developments in track circuits must be promptly reported to proper authority.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Alternating Current Track Circuits, Manual Part 162.

A.A.R. SIGNAL SECTION INSTRUCTIONS.

ELECTRONIC TUBES

1948

General.

1. Electronic tubes must be handled with care as they are exceedingly sensitive and delicate. They must not be dropped. When being transported, they must be properly protected to avoid damage.
2. When tubes are being changed, the power should be turned off, if possible. For certain type tubes, as instructed, the power must be turned off to avoid damage to the tubes.*
3. Tubes, when being removed, must be pulled straight out from the socket, using a gentle shaking motion. Tubes must not be rocked or twisted in socket, as such action may damage the tube base and the socket connections.
4. When a tube is removed, it must be determined that its socket is properly marked with tube identification number.
5. Before a tube is inserted into its socket, it must be determined that both tube and socket have corresponding identification numbers.
6. Accurate records must be kept as instructed showing date of installation, periodic testing and replacement.
7. The proper voltages must be applied to the tube elements. In no case should the voltages exceed the maximum ratings.
8. The color of tube heaters, filaments and plates should be noted. Too bright a heater or filament usually indicates excessive heater or filament voltage. Except as instructed for certain type tubes, a red plate indicates plate dissipation above the maximum rating.

Testing.

9. Tests must be made and recorded as instructed.
10. The preferred order for testing an electronic tube to check its condition is as follows:
 - (a) In its working circuit, if available, provided other elements of the circuit are known to be in proper operating condition.
 - (b) In a test circuit suitably arranged to provide a check of its performance compared with that of a similar perfect tube.
 - (c) In a proper tube checker to test the condition of the tube elements, the instrument employed being capable of measuring dynamic transconductance.
11. Tests using a tube checker should be made in accordance with instructions furnished with the instrument as follows:
 - (a) Test the heater or filament for continuity and emission.
 - (b) Test the tube for short circuits between elements. During this test the heater must be energized and the tube should be vibrated.
 - (c) Finally, the tube should be given a dynamic transconductance test. This test approximates actual operating conditions and is performed by the tube checker as follows:
 1. Proper voltages are applied to all electrodes.
 2. An alternating current voltage is applied to the control grid.

Testing.—Continued.

3. The alternating current component of the plate current is read by means of an alternating current milli-ammeter of the dynamometer type. The transconductance in micromhos equals

$$\frac{\text{a.c. plate current in mils}}{\text{a.c. grid voltage in volts}} \times 1000$$

4. The measured transconductance should be within the limits specified by the manufacturer of the apparatus in which the tube is used.

12. Instruments for testing electronic tubes must be checked frequently and calibrated when necessary.

13. Dynamic transconductance tests are to be preferred over static emission tests because static tests frequently show serviceable tubes to be defective and vice versa.

14. Certain special tubes and standard tubes used in special circuits must be tested in their working circuits or test circuits provided. The apparatus manufacturer's recommendations concerning test procedure and recording of data should be followed.

Action Recommended

Acceptance for submission to letter ballot.

(Revision of Instructions for Storage Batteries)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

STORAGE BATTERIES

1948

Present

31. Specific gravity readings must be taken with electrolyte at correct height and corrections made for temperature as follows:

(a) To correct to normal temperature, 70 degrees Fahrenheit, subtract one point (0.001 specific gravity) for each 3 degrees below 70 degrees Fahrenheit and add one point for each 3 degrees above 70 degrees Fahrenheit: for example, electrolyte reading 1.213 at 61 degrees Fahrenheit or 1.207 at 79 degrees Fahrenheit will be 1.210 at 70 degrees Fahrenheit.

33. Battery temporarily stored must be put in a dry clean location where temperature is above freezing and if practicable below 110 degrees Fahrenheit.

Proposed

31. Specific gravity readings must be taken with electrolyte at correct height and corrections made for temperature as follows:

(a) To correct to normal temperature, 77 degrees Fahrenheit, subtract one point (0.001 specific gravity) for each 3 degrees below 77 degrees Fahrenheit and add one point for each 3 degrees above 77 degrees Fahrenheit: for example, electrolyte reading 1.216 at 59 degrees Fahrenheit or 1.207 at 86 degrees Fahrenheit will be 1.210 at 77 degrees Fahrenheit.

33. Battery temporarily stored must be put in a dry clean location where temperature is above freezing and if practicable below 90 degrees Fahrenheit.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions 31 and 33 of Instructions for Storage Batteries,
Manual Part 14.

(Revision of Instructions for Electric Locks for Interlocking Machines)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

ELECTRIC LOCKS FOR INTERLOCKING MACHINES

1948

These instructions apply to electric locks manufactured in accordance with Specification 99, Manual Part 96. Locks of older or special design, or having special characteristics, must be maintained not only in accordance with these instructions in so far as possible, but also in accordance with manufacturer's instructions.

General.

1. Electric locks for new work or replacements must be in accordance with Specification 99, Manual Part 96.
2. Locks and their supports must be kept securely fastened.
3. Locks in service must have sufficient clearance between fixed and movable parts to insure free movement.
4. Covers must be kept in place and locked or sealed.
5. Bolts, nuts, dowels, screws, binding posts, rivets, nut locks, jam nuts, locking parts, etc., must be kept in place, in good condition, and tight.
6. Cotter pins of the proper size must be in place in holes provided for that purpose, must be in good condition and properly spread.
7. Edges of locking dogs and notches must be examined frequently and any having rounded or otherwise distorted locking surfaces must be replaced.
8. Lock plungers or dogs must not be lubricated.
9. Coils must be kept fixed in place to prevent movement due to vibration.
10. Armature end play must be maintained to not less than 0.010 nor more than 0.020 inch in direct current lock, and not less than 0.030 nor more than 0.035 inch in alternating current lock.
11. Magnetic air gap must not be changed in the field, and must in no case be less than that specified by the manufacturer for the particular type of lock.
12. Parts found defective must be replaced as promptly as possible.
13. Locks not meeting tests required by these instructions must be removed from service as promptly as possible and defects noted on repair tag Form 7018, Manual Part 124.

Contacts.

14. Finger contacts must meet contact surfaces squarely and simultaneously.
 - (a) Contacts must have a slide movement of not less than 0.010 inch against contact surface.
 - (b) Contact opening must be not less than 0.050 inch.

Notches for locks applied to mechanical machines.

15. The notch in the quadrant or slide bar must be so maintained that the locking face will meet squarely against the locking dog. Notch must be not less than $\frac{5}{16}$ inch deep and of length to provide at least $\frac{1}{4}$ inch back clearance. With lock de-energized, the locking dog or plunger must engage quadrant or slide bar at least $\frac{7}{32}$ inch and must clear bottom of notch in quadrant or slide bar. When lock is energized the locking dog or plunger must clear top of slide bar or quadrant at least $\frac{1}{32}$ inch.

Tests.

16. Meters for testing electric locks must be in accordance with Specification 85, Manual Part 168, must be checked frequently, and calibrated when necessary.

17. When making test of apparatus, proper instruments must be used, and it must be known that no unsafe conditions are set up by the application of testing equipment.

18. Locks must be tested periodically, as instructed, to determine that they are effective with lock circuit open and mechanical locking released. Test must be made by moving lever several times from normal or reverse position at varying impacts against electric lock stop.

19. Locks of solenoid gravity drop type must be disassembled periodically, as instructed, and plunger, tube and other working surfaces cleaned to insure proper operation. When reassembled and in place they must be tested for free movement of plunger and locking mechanism and as required in Instruction 18.

20. Pick-up and drop-away tests must be made periodically, as instructed.

21. Locks must meet shop requirements when placed in service, except in an emergency, when locks meeting field requirements may be used.

22. Insulation test must be made between all current-carrying parts and lock frames. The insulation resistance must be not less than 1 megohm. If high potential tests are made, the voltage employed should be 80 per cent of the value specified for a new lock in Specification 99, Manual Part 96.

Adjustments.

23. Latch operated locks.

(a) On mechanical interlocking levers locked in the normal or reverse position, the following clearances must be maintained:

1. Latch block lift, to permit operation of lever, must be not less than $\frac{3}{4}$ inch.

2. With electric lock de-energized and mechanical locking released, and with force applied to lever latch, the latch block lift must be not less than $\frac{1}{16}$ inch nor more than $\frac{1}{2}$ inch.

3. To insure that locking dog of the electric lock drops freely into locking notch before the mechanical locking is released, maximum looseness of mechanical locking must prevent the lever latch block from lifting more than $\frac{5}{16}$ inch.

4. The maximum movement of lever latch block, with lock quadrant or slide bar held stationary, must not exceed $\frac{1}{8}$ inch.

5. Mechanical interlocking levers locked in the normal or reverse indication position must be adjusted to hold latch block not less than $\frac{5}{8}$ inch from full down normal or reverse position as required by circuit plan.

24. Lever operated locks.

(a) On mechanical interlocking levers locked in the normal or reverse position, the following clearances must be maintained:

1. With mechanical locking released, the lock must lock the lever approximately $\frac{3}{4}$ inch measured on top surface of lever quadrant.

Adjustments.—Continued.

Locking notch in slide bar must provide at least $\frac{1}{8}$ inch back clearance from locking dog.

2. To insure that the locking dog of the electric lock is in locking position before the mechanical locking is released, the mechanical locking under the loosest locking condition must prevent lift of lever latch block more than $\frac{7}{16}$ inch.

3. On forced drop lever locks the first $\frac{1}{4}$ inch initial downward movement of the latch block must force the locking dog of the electric lock into locking engagement.

25. Switch levers (Model 2 and Model 2 unit lever, electric interlocking machines):

(a) With electric lock de-energized and mechanical locking released, the movement of the lever from normal toward reverse position must be not less than $\frac{13}{32}$ inch nor more than $\frac{1}{32}$ inch and reverse toward normal not less than $\frac{23}{32}$ inch nor more than $\frac{21}{32}$ inch.

(b) To insure that locking dog will drop freely into notch with reasonable clearance, the mechanical locking under the loosest locking condition must not permit movement of lever from normal toward reverse position of more than $\frac{5}{16}$ inch, and from reverse toward normal $\frac{3}{16}$ inch.

26. Switch levers (Model 5 electric interlocking machine):

(a) Movement of lever from normal toward reverse position with electric lock de-energized must be not less than $\frac{3}{8}$ inch nor more than $\frac{13}{32}$ inch; from reverse toward normal must be not less than $\frac{17}{32}$ inch nor more than $\frac{19}{32}$ inch.

(b) The locking dog of the electric lock must be forced into the locking position before the final movement of the lever latch block toward the normal or reverse locking position.

27. Switch levers (Model 14 power interlocking machine):

(a) With electric lock de-energized and mechanical locking released, adjust to permit longitudinal lock bar to move $\frac{3}{16}$ inch.

(b) To insure that locking dog can drop freely into notch with reasonable clearance, the mechanical locking under the loosest locking condition must prevent more than $\frac{3}{32}$ inch movement of longitudinal locking bar equivalent to 5 degree travel of the lever.

(c) The maximum movement of the longitudinal locking bar, with the locking segment and that portion of the shaft on which it is mounted held stationary, must not exceed $\frac{1}{4}$ inch.

28. Switch indicating levers (Style S-8 electro-mechanical interlocking machine):

(a) With electric lock de-energized and mechanical locking released, adjust to permit longitudinal lock bar to move $\frac{1}{4}$ inch or equivalent to 8 degree travel of the lever.

(b) To insure that locking dog can drop freely into notch with reasonable clearance, the mechanical locking under the loosest locking condition must prevent more than $\frac{5}{32}$ inch movement of longitudinal locking bar equivalent to 5 degree travel of the lever.

Adjustments.—Continued.

(c) The maximum movement of the longitudinal locking bar, with the shaft and locking segment of the machine held stationary, must not exceed $\frac{1}{16}$ inch as a result of lost motion in the driving connections.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Electric Locks for Interlocking Machines,
Manual Part 23.

(Revision of Instructions for Automatic Block Signaling Systems)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

AUTOMATIC BLOCK SIGNAL SYSTEMS

1948

1. Signals must be maintained and tested in accordance with Instructions for Light and Motor Semaphore Signals, Manual Part 54.
2. Clearances must be maintained as required.
3. Electric lamps must be maintained and tested in accordance with Instructions for Incandescent Electric Lamps, Manual Part 120.
4. Switch circuit controllers must be maintained and tested in accordance with Instructions for Switch Circuit Controllers, Manual Part 134.
5. Batteries must be maintained and tested in accordance with Instructions for Cells and Batteries, Manual Parts 7 and 14.
6. Track circuits must be maintained and tested in accordance with Instructions for Track Circuits, Manual Parts 8, 162 and 218.
7. Wire and cable must be maintained and handled in accordance with Instructions for Wire and Cable, Manual Part 190.
8. Relays must be maintained and tested in accordance with Instructions for Relays, Manual Parts 124 and 126.
9. Rectifiers and motor-generators must be maintained and tested in accordance with Instructions for Rectifiers and Motor-Generators, Manual Part 68.
10. Insulated rail joints must be maintained and tested in accordance with Instructions for Insulated Rail Joints, Manual Part 133.
11. Circuits must not be opened or shunted, contacts of controlling devices bridged, or any other action taken which may affect the safety of train operation.
12. Maintenance and repair work which may interfere with safe movement of trains must not be started until train movements have been fully protected. Temporary repairs or adjustments, when required, must be made in such a manner that safety of operation will not be impaired.
13. Before removing rails, switch points or movable point frogs, protecting signals must be secured to display their most restrictive indication. Signals must not be restored to normal operation until tests have been made and it is known that they function as intended and that the track is safe for train operation.
14. Contacts must be kept clean and in proper adjustment.
15. Circuits, other than track circuits, should be kept free of grounds.
16. Lightning arresters and made grounds must be properly connected and maintained.
17. Movable parts must be kept clean, properly adjusted and must move freely under all weather conditions. Parts worn to such an extent as to create excessive lost motion must be replaced.
18. Wires and tags must be so arranged as not to interfere with the operating parts of apparatus.
19. Seals and padlocks, where provided, must be maintained and handled in accordance with instructions.

20. Bearings must be lubricated as instructed and kept free from grit and dirt.

21. Housings must be kept clean and must not be used for storing material, tools or supplies unless special provision is made. They should not be opened in severe or stormy weather, except when conditions require.

22. Doors, covers and fastenings must be kept in good condition, with suitable gaskets in place so as to keep out moisture and dirt.

23. Bolts, nuts, pins and cotters of proper size and type must be kept in place, nuts kept tight and cotters properly spread.

24. Paint must be applied as often as required to prevent deterioration. Rusty surfaces must be cleaned before painting. Paint must not be applied to threads of screw jaws, adjusting screws, cotters or gaskets.

Tests.

25. Tests must be made periodically, as instructed, to determine that the various safety features are effective.

26. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

27. When repair, adjustment, change or replacement is made in any part which may affect the operation of the system, tests must be made immediately to determine that proper operation is assured.

28. In case of severe storm, inspection must be made as soon as practicable and any trouble corrected.

29. Ground resistance tests must be made in accordance with Instructions for Resistance of Made Grounds, Manual Part 61.

30. Insulation resistance tests must be made in accordance with Instructions for Insulation Resistance, Manual Part 130.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Automatic Block Signaling Systems,
Manual Part 102.

(Revision of Instructions for Switch Circuit Controllers)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

SWITCH CIRCUIT CONTROLLERS

1948

1. Switch circuit controllers must be securely fastened to ties.
2. Movable parts must be kept clean, properly adjusted and must move freely under all weather conditions. Parts worn to such an extent as to create excessive lost motion must be replaced.
3. Contacts must be kept clean and in proper adjustment, with contact opening of not less than $\frac{1}{16}$ inch when open.
4. Switch circuit controller connected directly to the point of a switch must be so maintained that the circuits will be closed or opened as required before the switch point opening exceeds the following:
 - (a) $\frac{1}{4}$ inch on facing point switch.
 - (b) $\frac{3}{8}$ inch on trailing point switch.

Adjustment must not be made by bending contacts.

5. Switch circuit controller operated by switch-and-lock movement must be so maintained that the circuits will remain open or closed as required until the locking dog has entered the locking notch of the lock rod $\frac{1}{2}$ inch or more.

6. Switch circuit controller operated by a facing point lock independent of the switch operating device, must be so maintained that the circuits will remain open or closed as required until the locking bar has passed completely through the lock rod.

7. Bolts, nuts, pins and cotters of proper size and type must be kept in place, nuts kept tight and cotters properly spread.

8. Bearings must be lubricated as instructed and kept free from grit and dirt.

9. Covers and fastenings must be kept in good condition with suitable gaskets in place, so as to keep out moisture and dirt.

10. Ventilators must be kept free from obstruction.

11. Wire entrances must be kept sealed.

12. Threads of rods, jaws and bolts must be kept clean and properly lubricated.

13. Paint must be applied as often as required to prevent deterioration. Rusty surfaces must be cleaned before painting. Paint must not be applied to threads of screw jaws, adjusting screws, cotters or gaskets.

Tests.

14. Tests must be made to determine that with the switch fully open or locking dog or bar fully withdrawn, switch circuit controller contacts will not open or close improperly.

15. Switch circuit controller shunting circuit resistance tests must be made as instructed.

16. Tests must be made to insure that movement of a train over switch, derail or movable point frog will not cause switch circuit controller contacts to open or close improperly.

Repairing.

17. Switch circuit controllers not meeting requirements must be removed from service as promptly as possible and defects noted on repair tag Form 7018, Manual Part 124.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Switch Circuit Controllers,
Manual Part 134.

(Revision of Instructions for Automatic Highway Grade Crossing Protective Systems)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

**AUTOMATIC HIGHWAY GRADE CROSSING
PROTECTIVE SYSTEMS**

1948

General.

1. Protective devices must be kept in good condition and maintained in accordance with instructions issued by proper authority. Signs, lenses, reflectors and roundels must be kept clean and intact. Operating mechanisms must be kept free from dirt, and excessive grease and lost motion. All bearings must be properly lubricated. Contacts must be kept clean and in proper adjustment.
2. Clearances should be maintained as required.
3. Electric lamps must be maintained and tested in accordance with Instructions for Incandescent Electric Lamps, Manual Part 120.
4. Switch circuit controllers must be maintained and tested in accordance with Instructions for Switch Circuit Controllers, Manual Part 134.
5. Batteries must be maintained and tested in accordance with Instructions for Cells and Batteries, Manual Parts 7 and 14.
6. Track circuits must be maintained and tested in accordance with Instructions for Track Circuits, Manual Parts 8, 162 and 218.
7. Wire and cable must be maintained and handled in accordance with Instructions for Wire and Cable, Manual Part 190.
8. Relays must be maintained and tested in accordance with Instructions for Relays, Manual Parts 124 and 126.
9. Rectifiers must be maintained and tested in accordance with Instructions for Rectifiers and Motor-Generators, Manual Part 68.
10. Insulated rail joints must be maintained and tested in accordance with Instructions for Insulated Rail Joints, Manual Part 133.
11. Proper precautions must be taken before changes or interruptions are made in track or other circuits affecting operation of crossing protective systems.
12. Circuits, other than track circuits, should be kept free of grounds.
13. Wires and tags must be so arranged as not to interfere with operating parts of apparatus.
14. Lightning arresters and made grounds must be properly connected and maintained.
15. Doors, covers, and fastenings must be kept in good condition with suitable gaskets in place to keep out moisture and dirt.
16. Paint must be applied as often as required to prevent deterioration. Rusty surfaces must be cleaned before painting. Paint must not be applied to gaskets.

Inspections and tests.

17. Tests must be made periodically, as instructed, to determine that the various safety features are effective.

18. When repair, adjustment, change or replacement is made in any part which may affect the operation of the system, test must be made to determine that proper operation is assured.

19. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

20. In case of severe storm, inspection must be made as soon as practicable and any trouble corrected.

21. Signals must be checked, as instructed, from each highway approach to insure that they are properly aligned and that view of signal is not obstructed.

22. Insulation resistance tests must be made in accordance with Instructions for Insulation Resistance, Manual Part 130.

23. Ground resistance test must be made in accordance with Instructions for Resistance of Made Grounds, Manual Part 61.

24. Performance of protective devices must be checked periodically, as instructed, and recorded on Form 7054.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Automatic Highway Grade Crossing Protective Systems,
Manual Part 150.

(Revision of Instructions for Facing Point Locks Applied to Spring Switches)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

FACING POINT LOCKS APPLIED TO SPRING SWITCHES

1948

1. Facing point lock movement, tie plates, gage plates and crank stand must be kept securely fastened together and to the ties.
2. Special rail stop must be securely fastened to the switch point and the switch should be free and in proper alignment so that the rail stop will bear positively against the stock rail when the switch is thrown slowly to the normal position by hand, and also return against the stock rail after the switch has been pried away by means of a bar inserted as near the stop as possible.
3. Connections operating the locking plunger must be kept tight and the end of plunger must have square edges.
4. Holes or notches in lock rods must have square edges and must be not more than $\frac{1}{8}$ inch larger than plunger.
5. Lock rods must be so maintained that when switch is operated by hand toward its normal position, the plunger will not enter the lock rod when $\frac{1}{4}$ inch obstruction is placed between the stock rail and switch point 6 inches from point of switch.
6. Point detector circuit controller must be so maintained that the contacts will not assume the positions indicating point closure if switch point is closed with a $\frac{1}{4}$ inch obstruction placed between the stock rail and switch point 6 inches from point of switch.
7. Tests must be made periodically, as instructed, with slow moving train trailing through switch to determine that end of locking plunger is withdrawn from the lock rod without binding.
8. Locking plunger contacts must be so maintained that disconnection of the locking plunger connection at its point of attachment to the switch, when the switch and switch operating mechanism are in normal position, must either:
 - (a) Prevent contacts from assuming the position indicating point closure, or
 - (b) Operate other contacts to indicate separately that plunger has over-travelled.
9. Facing point mechanism must be maintained and adjusted in accordance with manufacturer's instructions unless they conflict with other general or detailed instructions in which case, proper authority must be consulted.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Facing Point Locks Applied to Spring Switches,
Manual Part 159.

A.A.R. SIG. SEC. 1673C (Three Sheets).

GRAPHICAL SYMBOLS—RELAYS

This drawing has been revised to include symbols for "Retained Neutral," "Neutral Magnetic Stick," "Polarized Magnetic Stick" and "Biased Neutral" relays.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

A.A.R. Sig. Sec. 1673B—Graphical Symbols—Relays (Two Sheets).

A.A.R. SIG. SEC. 1674D (Three Sheets).

GRAPHICAL SYMBOLS—RELAY CONTACTS

This drawing has been revised to include relay contact symbols for neutral and polar biased relays.

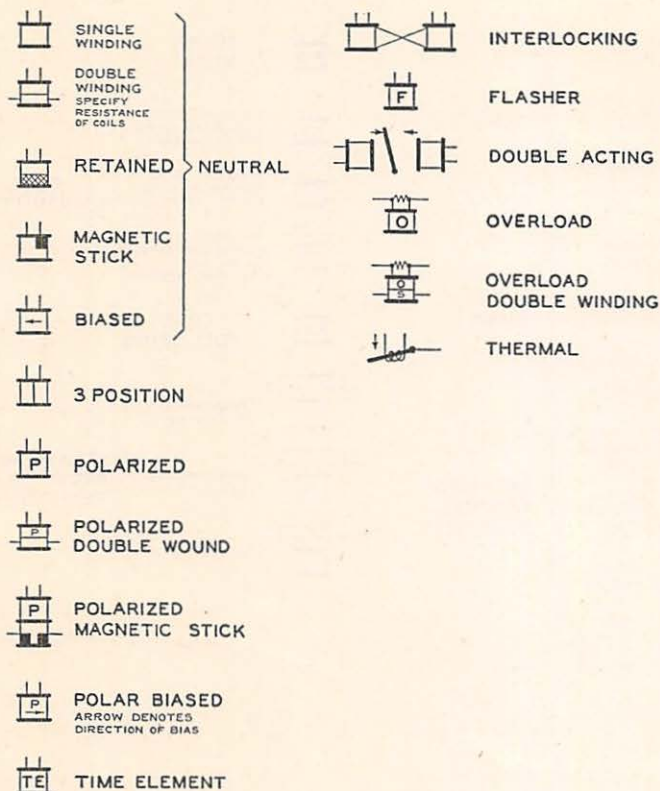
Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

A.A.R. Sig. Sec. 1674C—Graphical Symbols—Relay Contacts (Two Sheets).

DIRECT CURRENT RELAYS



NOTE:

ABOVE SYMBOLS MAY BE COMBINED AS REQUIRED.
SYMBOLS AS SHOWN ARE FOR RELAYS DESIGNED
FOR VITAL CIRCUITS.

SYMBOLS FOR RELAYS DESIGNED FOR NON-VITAL
CIRCUITS TO BE SHOWN THUS **NV**

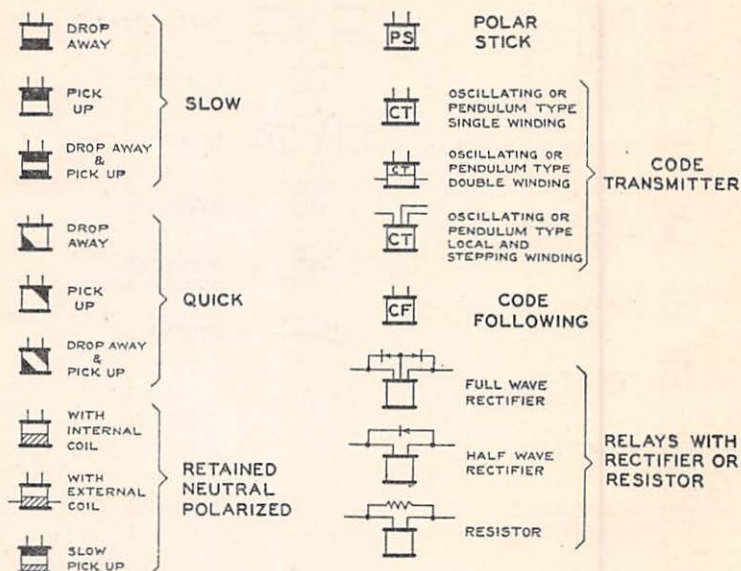
ALL SPECIAL FEATURES NOT COVERED BY SYMBOLS
TO BE NOTED ON CIRCUIT PLANS.

GRAPHICAL SYMBOLS
RELAYS

AAR
SIG. SEC.
1673C

SEPT-1948 M-1943 OCT-1943 M-1934 MAR-1934

DIRECT CURRENT RELAYS



NOTE:

ABOVE SYMBOLS MAY BE COMBINED AS REQUIRED.
SYMBOLS AS SHOWN ARE FOR RELAYS DESIGNED FOR VITAL CIRCUITS.

SYMBOLS FOR RELAYS DESIGNED FOR NON-VITAL CIRCUITS TO BE SHOWN THUS **[NV]**

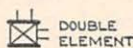
ALL SPECIAL FEATURES NOT COVERED BY SYMBOLS TO BE NOTED ON CIRCUIT PLANS.

GRAPHICAL SYMBOLS
RELAYS

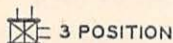
AAR
SIG. SEC.
1673C

SEPT-1948 M-1943 OCT-1943 M-1934 MAR-1934

ALTERNATING CURRENT RELAYS

SINGLE
ELEMENTDOUBLE
ELEMENT

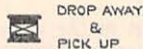
2 POSITION



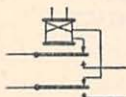
3 POSITION

DROP
AWAYPICK
UP

SLOW

DROP AWAY
&
PICK UPDROP
AWAYPICK
UP

QUICK

PICK UP
DROP AWAY

POWER TRANSFORMER RELAY



TIME ELEMENT



INTERLOCKING



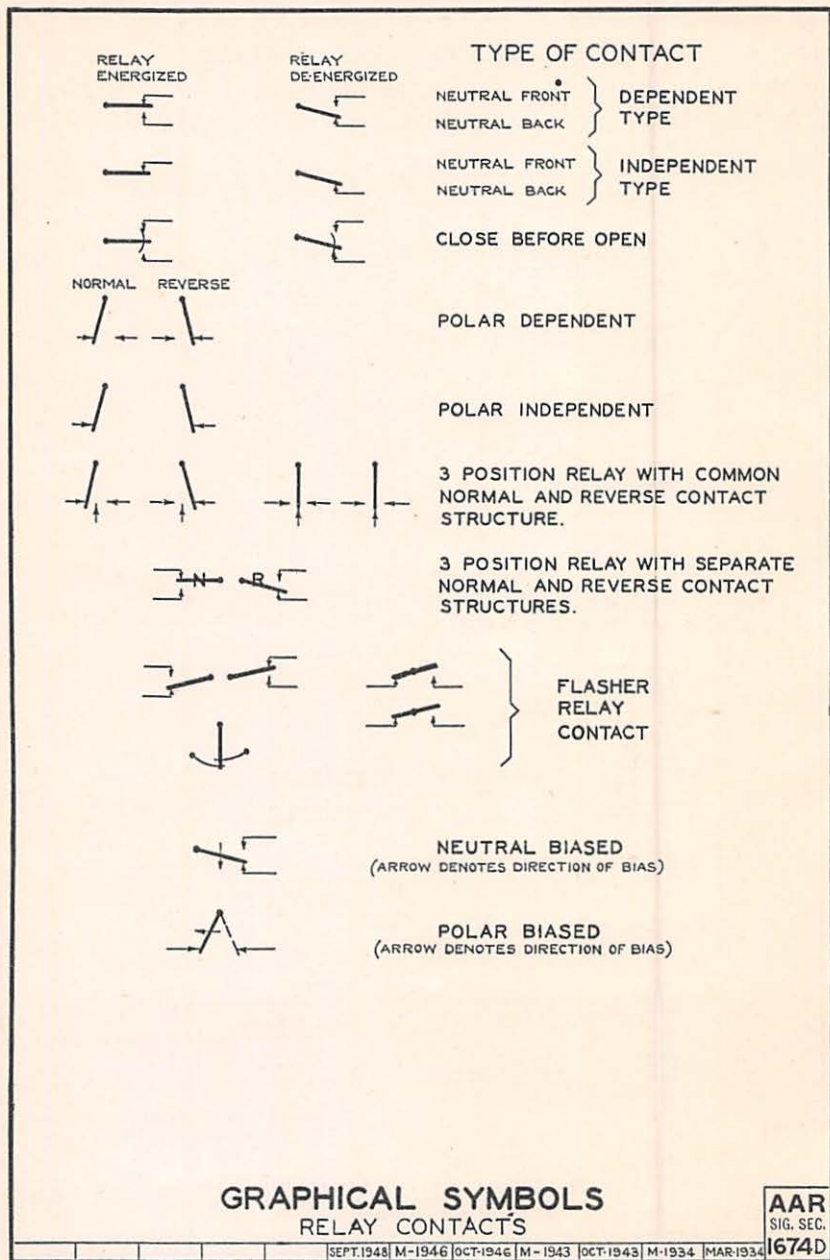
FLASHER

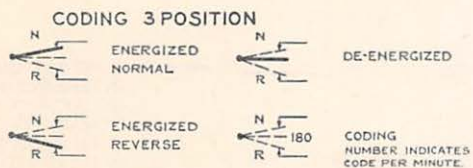
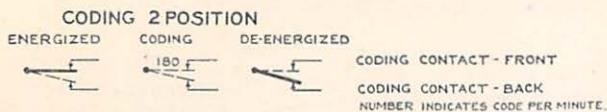
CODE
TRANSMITTER

NOTE:

ABOVE SYMBOLS MAY BE COMBINED
AS REQUIRED.SYMBOLS AS SHOWN ARE FOR RELAYS
DESIGNED FOR VITAL CIRCUITS.SYMBOLS FOR RELAYS DESIGNED FOR
NON-VITAL CIRCUITS TO BE SHOWN THUS NVALL SPECIAL FEATURES NOT COVERED BY
SYMBOLS TO BE NOTED ON CIRCUIT PLANS.GRAPHICAL SYMBOLS
RELAYSAAR
SIG. SEC.
1673C

SEPT-1948 M-1943 OCT-1943 M-1934 MAR-1934





180DU
NUMBER INDICATES CODE PER
MINUTE TO WHICH UNIT IS TUNED.

DECODING UNIT

GRAPHICAL SYMBOLS RELAY CONTACTS

AAR
SIG. SEC.

1674D

SEPT-1948 M-1946 OCT-1946 M-1943 OCT-1943 M-1934 MAR-1934

RELAY CONTACTS WITH SPECIAL CHARACTERISTICS

 HIGH CURRENT

 CHECKING CONTACT
FOR TIME ELEMENT RELAY.

 HIGH VOLTAGE

 FRONT

 HIGH VOLTAGE AND
HIGH CURRENT

 BACK

 CONTACT ON
INTERLOCKING
RELAY WHICH
REMAINS CLOSED
WITH ARMATURE
IN INTERMEDIATE
POSITION.

 MAGNETIC BLOWOUT
GRAPHICAL SYMBOLS
RELAY CONTACTSAAR
SIG. SEC.
1674D

SEPT 1948 | M-1946 | OCT 1946 | M-1943 | OCT 1943 | M-1934 | MAR 1934

COMMITTEE VI—DESIGNS

Personnel

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W. A. Ford

C. H. Tobin

A. S. Haigh

C. N. Tymeson

A. J. Yarrell

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Designs.
4. Specifications and drawings covering reflector lenses and similar devices for signals and signs, collaborating with Committee VIII.
5. Simplification of sizes and kinds of electric lamps for signal purposes, co-operating with Purchases and Stores Division, A.A.R.
6. Investigate and report on the use of safety nuts in signal apparatus.
7. Specification for concrete, reinforcement and test requirements for precast concrete foundations, monolithic and sectional types.
8. Specification for flashing light signal light unit with doublet lens.
9. Design an improved universal adjustment basket for switch layouts.
10. Specification for electric light unit for application to highway crossing gate arms.

The Committee submits for consideration, reports on the following subjects*:

1. Revised drawings.
Drawings to be made obsolete.
Revision of Specification 69-40, Manual Part 136.
3. New drawings.
6. Use of safety nuts in signal apparatus.
8. Specification 232-48.
Cooperative report. Joint Committee on Metric System, A.A.R.

Explanatory

The revision of Specification 69, Manual Part 136, includes red for electric hand lantern lenses, specification for standard duplicate limit glasses in the 1

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 17, 1948.

inch red disc, and also provides for the 1 inch disc in blue and lunar white together with other minor changes in phraseology suggested by the Bureau of Standards. The revision of Part C broadens the specification to include clear roundels, lenses, etc., also specifies marking and packing requirements in accordance with present practice.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.S.T.M.—American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

Disposition of 1947 Letter Ballot Subjects

The following subjects presented by this Committee in the 1947 Annual Meeting Advance Notice were submitted to letter ballot and officially approved:

- A.A.R. Sig. Sec. 1021C—Guide Clamps for Vertical Connections on Signals—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1083C—"U" Bolt and Clamp for Signal Masts—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1103B—Concrete Foundation for Horizontal Crank Stands—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1104B—Foundation for Compensator—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1250B—Base for 5 Inch Mast—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1346B—Electric Hand Lantern—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1489C—Automatic Crossing Gate and Signal Assembly—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1567B—Mechanical Dwarf Signal—Details—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1616C—Light Signal Masts—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1640C—90 Degree Cast-Iron Crossing Sign—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1641C—Double Adapter Clamp and Details for Crossing Signs for 3 to 8 Inch Pipe—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1642D—90 Degree Reflector Crossing Sign Assembly—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1643D—90 Degree Reflector Crossing Sign Details—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1644C—Cast-Iron Multiple Track Sign—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1645C—Reflector Multiple Track Sign—Now in Drawing Section of Manual.

- A.A.R. Sig. Sec. 1646C—Reflector Stop on Red Signal Sign—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1647D—Single Adapter Clamp and Details for Crossing Signs for 3 to 8 Inch Pipe—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1648C—Reflector Stop When Swinging Sign—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1650C—Details of Numerals for Track Signs—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1651E—Highway Crossing Signal Assembly—Wig-Wag Type—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1652E—Highway Crossing Signal Assembly—Wig-Wag Type—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1653E—Highway Crossing Signal Assembly—Flashing Light Type—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1654E—Highway Crossing Signal Assembly—Flashing Light Type—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1655C—Bolts for Crossing Signs for 4 or 5 Inch Pipe—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1656C—Junction Box and Cross-Arm Assembly for Flashing Light Highway Crossing Signals—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1657C—Junction Box and Cross-Arm Details for Flashing Light Highway Crossing Signals—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1686E—Highway Crossing Flashing Light Signal Assembly—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1688C—Highway Crossing Flashing Light Signal Assembly—10 Ft. and 12 Ft. Cantilever Span—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1691D—Highway Crossing Sign—50 Degree Reflector Type—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1692B—50 Degree Reflector Crossing Sign Assembly—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1693C—50 Degree Reflector Crossing Sign Details—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1504B—Lever Number Plate for Mechanical Interlocking Machine—Removed from Drawing Section of Manual.
- A.A.R. Sig. Sec. 1615A—Foundation for Mechanical Dwarf Signals—Removed from Drawing Section of Manual.
- A.A.R. Sig. Sec. 1622A—Tags for Marking Wires—Removed from Drawing Section of Manual.
- A.A.R. Sig. Sec. 1623A—Pattern and Mold for Arbitration Test Bar—Removed from Drawing Section of Manual.
- A.A.R. Sig. Sec. 1649A—Reflector Crossing Signal Marker—Removed from Drawing Section of Manual.
- A.A.R. Sig. Sec. 1696A—Extension Brackets for Crossing Signs—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1697A—Bolts for Crossing Signs for 6 Inch Pipe—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1698A—Bolts for Crossing Signs for 8 Inch Pipe—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1699A—Bolts for Junction Box and Cross-Arm for 4, 5, 6, 8 Inch Pipe—Now in Drawing Section of Manual.

REVISED DRAWINGS

A.A.R. Sig. Sec. 1015C—One Inch Signal Pipe and Coupling.

Detail 10152 changed to SAE 1020 steel. Tolerance shown for pitch diameter.

A.A.R. Sig. Sec. 1023D—Guides for Vertical Mechanical Connections for 5 and 6-Inch Masts—Assemblies.

Title changed. Drawing changed to conform with present drafting practices.

A.A.R. Sig. Sec. 1059C—Clamp for Base of 6-Inch Ground Masts—Details and Assembly.

Title changed. In detail 10592, "lock" inserted between "spring" and "washers." Plating and spring lock washer notes added. Drawing changed to conform with present drafting practices.

A.A.R. Sig. Sec. 1083D—Bolt and Clamp for 5-Inch Masts.

Title changed. Drawing changed to conform with present drafting practices.

A.A.R. Sig. Sec. 1178D—Clamps for Base of 5-Inch Bridge Masts—Details and Assemblies.

Title changed. Drawing changed to conform with present drafting practices. Footnote added to cover painting.

A.A.R. Sig. Sec. 1346C—Electric Hand Lantern.

Title changed. Reference added for white lantern.

A.A.R. Sig. Sec. 1355C—Crank Bearings and Clamps for Base of 6-Inch Masts—Details and Assemblies.

Title changed. Drawing changed to conform with present drafting practices. Footnote added to cover painting.

A.A.R. Sig. Sec. 1357D—Ladders for Ground Masts for Two-way Signals—Details and Assemblies.

Title changed. Drawing changed to conform with present drafting practices.

A.A.R. Sig. Sec. 1362D—Ladder Parts—Details.

Drawing changed to conform with present drafting practices.

A.A.R. Sig. Sec. 1363C—Ladder Handrails—Details and Assemblies.

A.A.R. Sig. Sec. 1364D—Ladder Platforms—Details and Assemblies.

Dimensions corrected. Drawings changed to conform with present drafting practices.

A.A.R. Sig. Sec. 1365D—Ladders for Ground Masts with Platforms—Assemblies.

Title changed. Drawing changed to conform with present drafting practices.

A.A.R. Sig. Sec. 1366D—Ladders for Bridge Masts—Assemblies.

Drawing changed to conform with present drafting practices.

A.A.R. Sig. Sec. 1371D—Ladder Clamps and Stays—Details and Assemblies.
Dimensions corrected. Drawing changed to conform with present drafting practices.

A.A.R. Sig. Sec. 1491D—Highway Crossing Gate Arm.

Detail 14911 removed as it is obsolete. Drawing revised to provide one type gate arm for all types of mechanism. Details of gate arm revised to agree with present manufacturing practice. Footnote covering bolts, nuts and threads added.

A.A.R. Sig. Sec. 1583D—Ladders for Ground Masts without Platforms—Assemblies.

Title changed. Drawing changed to conform with present drafting practices.

A.A.R. Sig. Sec. 1585D—Ladder Parts—Details and Assemblies.

Dimension corrected.

A.A.R. Sig. Sec. 1609B—Electric Hand Lantern Lens.

Revised to show improved design of lens.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

A.A.R. Sig. Sec. 1015B—One Inch Signal Pipe and Coupling.

A.A.R. Sig. Sec. 1023C—Guides for Vertical Connections on Signals (Assembly).

A.A.R. Sig. Sec. 1059B—Clamp for Base of Ground Mast Signals (Details and Assembly).

A.A.R. Sig. Sec. 1083C—"U" Bolt and Clamp for Signal Masts.

A.A.R. Sig. Sec. 1178C—Clamps for Base of Bridge Masts (Details and Assembly).

A.A.R. Sig. Sec. 1346B—Red Electric Hand Lantern.

A.A.R. Sig. Sec. 1355B—Crank Bearings and Clamps (for Two-Way Single-Lamp Signal).

A.A.R. Sig. Sec. 1357C—Ladders for Two-Way Single-Lamp Signal.

A.A.R. Sig. Sec. 1362C—Ladder Parts (Details).

A.A.R. Sig. Sec. 1363B—Ladder Handrails (Details and Assembly).

A.A.R. Sig. Sec. 1364C—Ladder Platforms (Details and Assembly).

A.A.R. Sig. Sec. 1365C—Ladders for Ground Mast Signals (Assembly).

A.A.R. Sig. Sec. 1366C—Ladders for Bridge Masts.

A.A.R. Sig. Sec. 1371C—Ladder Clamps and Stays (Details and Assembly).

A.A.R. Sig. Sec. 1491C—Crossing Gate Arm.

A.A.R. Sig. Sec. 1583C—Ladders for Ground Masts (Assembly).

A.A.R. Sig. Sec. 1585C—Ladder Parts.

A.A.R. Sig. Sec. 1609A—Electric Hand Lantern Lens.

DRAWINGS TO BE MADE OBSOLETE

Drawing 1176—Trunking—Grooved Type.

Drawing 1177—Trunking—Built Up Type.

As these drawings are no longer in general use, it is recommended they be removed from the Manual.

Action Recommended

Acceptance for submission to letter ballot for removal from the Manual.

NEW DRAWINGS

A.A.R. Sig. Sec. 1481A—Electric Light Unit—Illuminated Highway Crossing Sign.

A.A.R. Sig. Sec. 1482A—Illuminated Highway Crossing Sign—Front of Mast Mounting for 4 to 8-Inch Pipe.

A.A.R. Sig. Sec. 1483A—Illuminated Highway Crossing Sign—Side of Mast Mounting for 4 to 8-Inch Pipe.

A.A.R. Sig. Sec. 1484A—Adapter Clamp—Illuminated Highway Crossing Sign—Front of Mast Mounting for 4 to 8-Inch Pipe.

A.A.R. Sig. Sec. 1485A—Bracket—Illuminated Highway Crossing Sign.

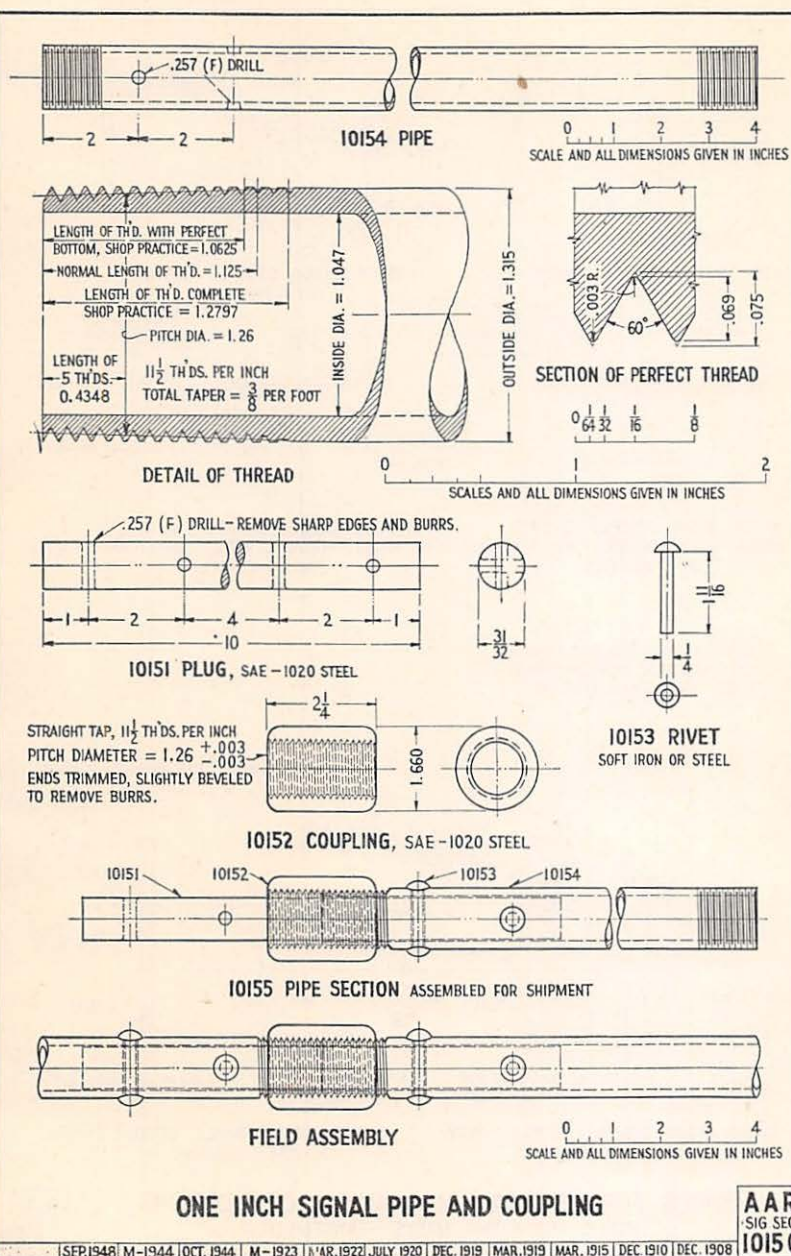
A.A.R. Sig. Sec. 1486A—Adapter Clamp—Illuminated Highway Crossing Sign—Side of Mast Mounting for 4 to 8-Inch Pipe.

A.A.R. Sig. Sec. 1487A—Sign and Cover Glass Roundels—Illuminated Highway Crossing Sign.

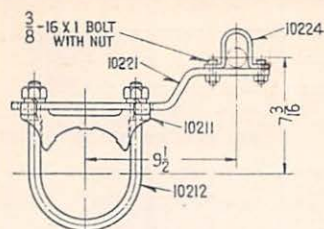
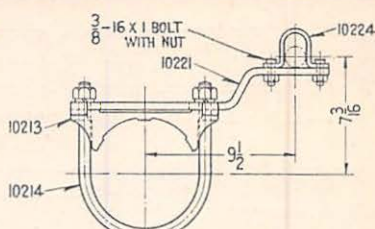
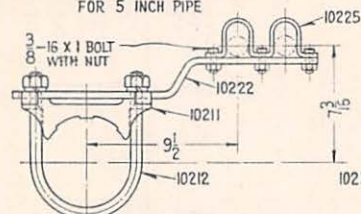
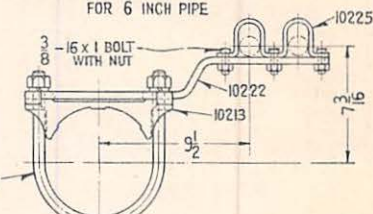
These drawings were prepared to show assembly and details of illuminated highway crossing sign displaying "No Right Turn" and "No Left Turn" legend meeting the requirements of Specification 231, Manual Part 237.

Action Recommended

Acceptance for submission to letter ballot.

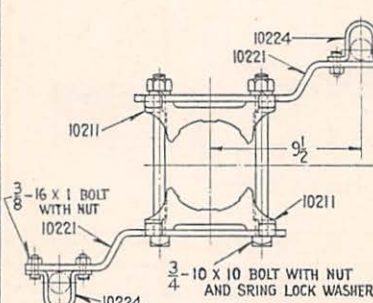
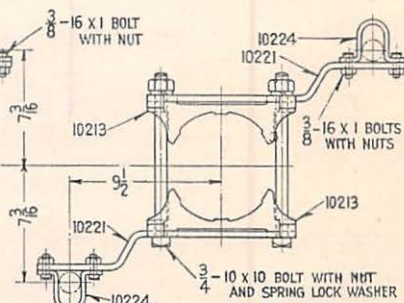


Parts shall be in accordance with Specification 122, Manual Part 114.

10231 GUIDE COMPL. 1-WAY
FOR 5 INCH PIPE10232 GUIDE COMPL. 1-WAY
FOR 6 INCH PIPE10233 GUIDE COMPL. 2-WAY
10234 GUIDE COMPL. WITH 1-WAY CAP 10224
FOR 5 INCH PIPE10235 GUIDE COMPL. 2-WAY
10236 GUIDE COMPL. WITH 1-WAY CAP 10224
FOR 6 INCH PIPE

STRAIGHT BOLTS AND NUTS SHALL BE
GALVANIZED OR CADMIUM PLATED
AFTER THREADS HAVE BEEN CUT.

0 3 6 9 12
SCALE AND ALL DIMENSIONS GIVEN IN INCHES

10233 GUIDE COMPL. DOUBLE 1-WAY
FOR 5 INCH PIPE10235 GUIDE COMPL. DOUBLE 1-WAY
FOR 6 INCH PIPE

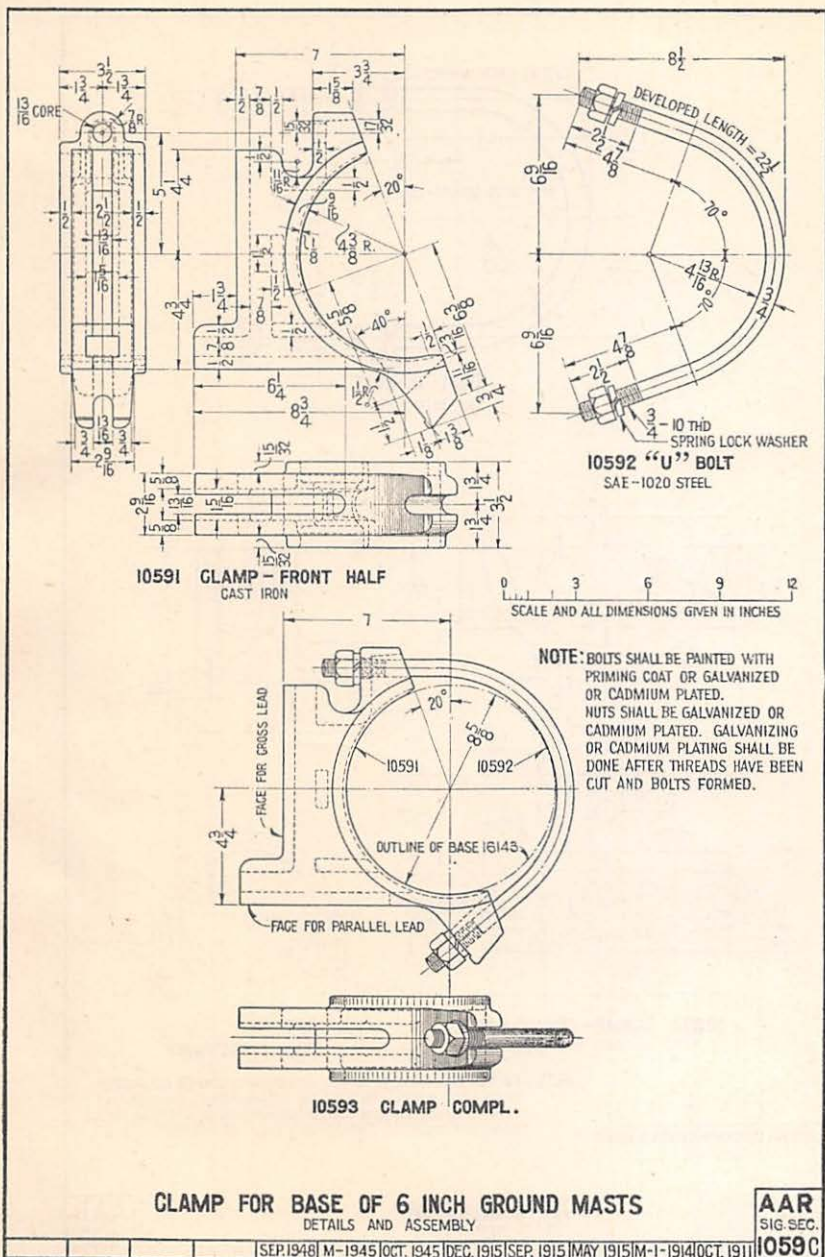
GUIDES FOR VERTICAL MECHANICAL CONNECTIONS FOR 5 AND 6 INCH MASTS — ASSEMBLIES

AAR
SIG. SEC.

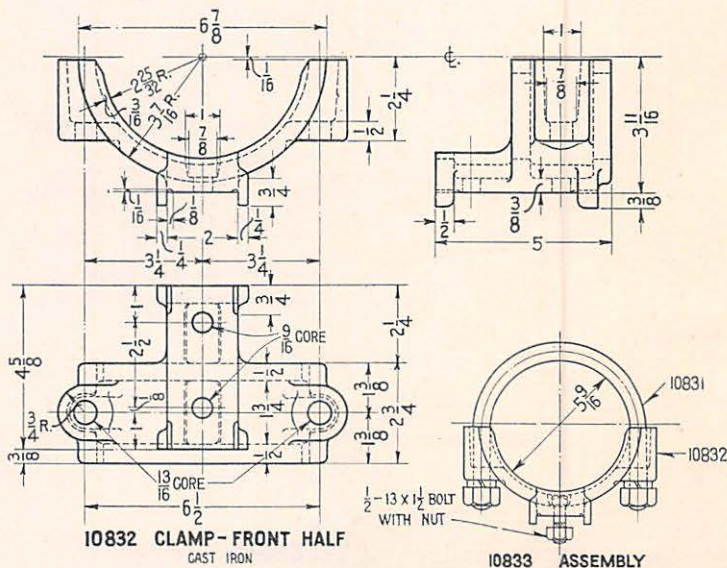
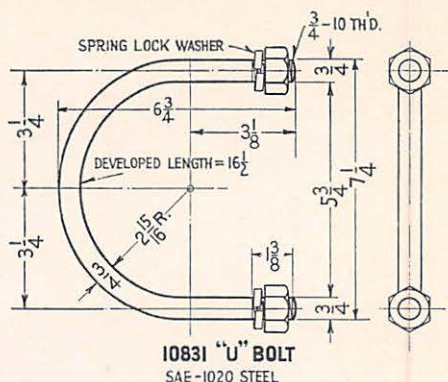
1023D

SEP. 1948 | M-1945 | OCT. 1945 | M-1935 | MAR. 1935 | MAR. 1915

Spring lock washers shall be carbon steel (A.S.A. current Specification B27.1 is preferred, where practicable). Bolts, nuts and threads shall be in accordance with Specification for Bolts, Nuts and Threads, Manual Part 17.



Cast iron shall be in accordance with Specification for Gray Iron Castings, Manual Part 88; Bolts, nuts and threads shall be in accordance with Specification for Bolts, Nuts and Threads, Manual Part 17; Painting shall be in accordance with Specification 120, Manual Part 110; Spring lock washers shall be carbon steel (A.S.A. current Specification B27.1 is preferred, where practicable).



0 1 2 3 4 5 6
SCALE AND ALL DIMENSIONS GIVEN IN INCHES

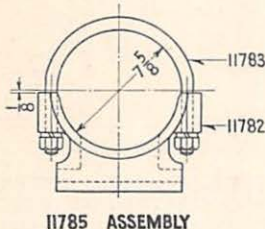
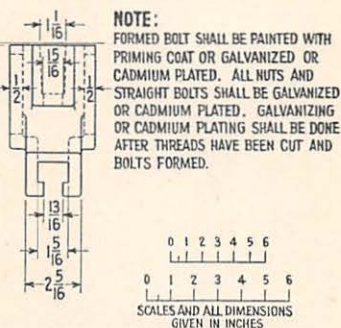
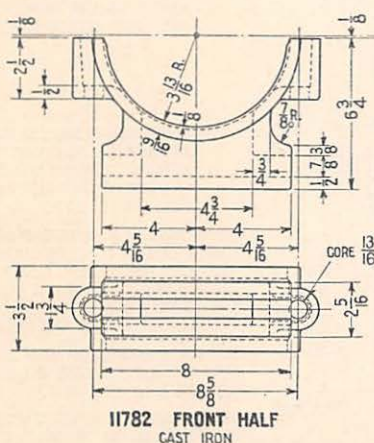
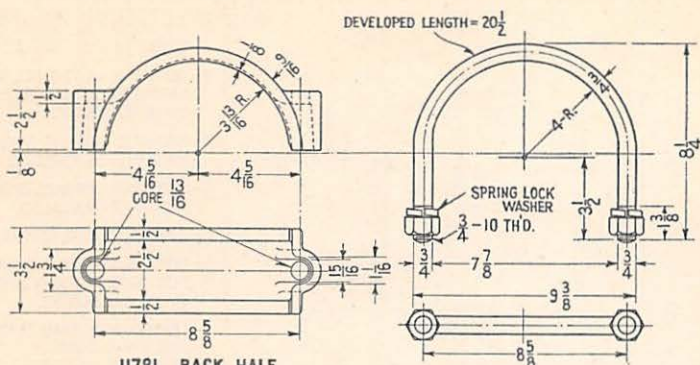
NOTE: FORMED BOLT SHALL BE PAINTED WITH PRIMING COAT OR GALVANIZED OR CADMIUM PLATED. ALL NUTS AND STRAIGHT BOLTS SHALL BE GALVANIZED OR CADMIUM PLATED. GALVANIZING OR CADMIUM PLATING SHALL BE DONE AFTER THREADS HAVE BEEN CUT AND BOLTS FORMED.

BOLT AND CLAMP FOR 5 INCH MASTS

SEP. 1948 | M-1947 | SEP. 1947 | M-1945 | OCT. 1945 | MANUAL-FEB. 1914 | OCT. 1910

AAR
SIG. SEC.
10832D

Cast iron shall be in accordance with Specification for Gray Iron Castings, Manual Part 88; Bolts, nuts and threads shall be in accordance with Specification for Bolts, Nuts and Threads, Manual Part 17; Painting shall be in accordance with Specification 120, Manual Part 110; Spring lock washers shall be carbon steel (A.S.A. current Specification B27.1 is preferred, where practicable).



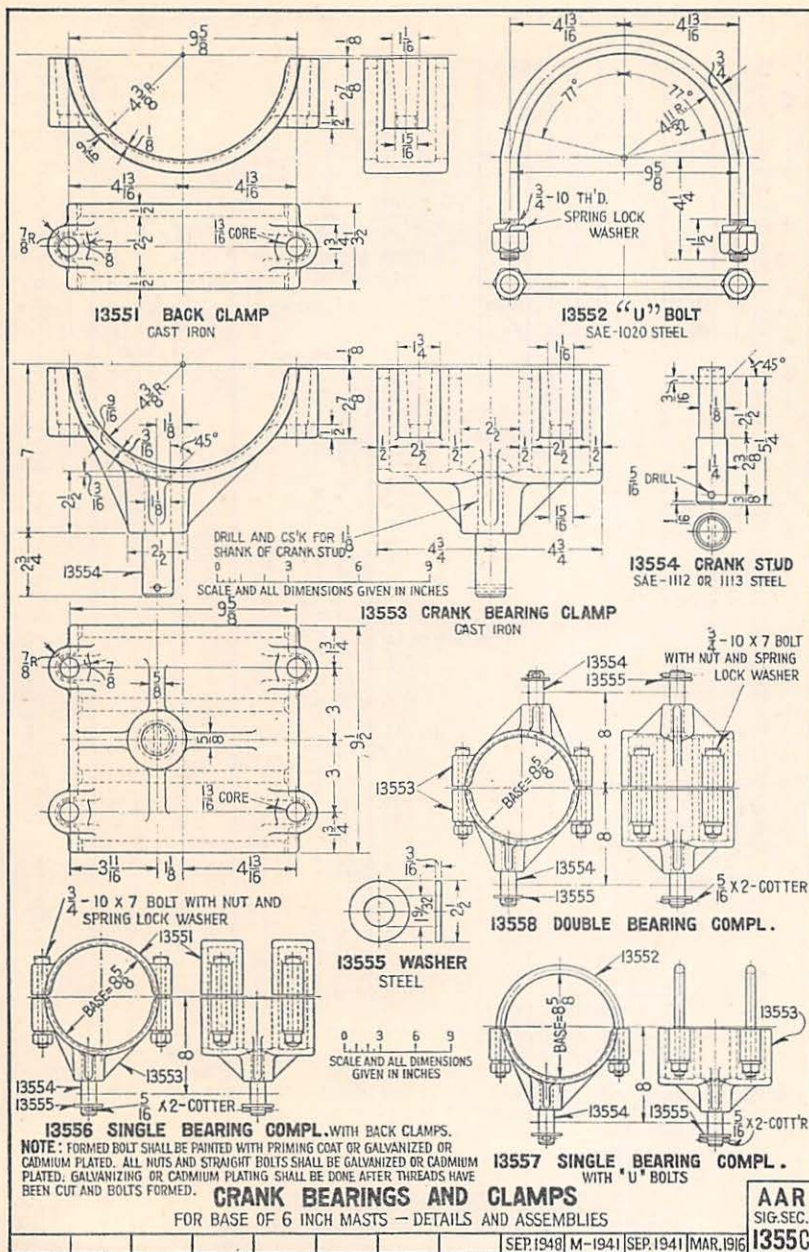
CLAMPS FOR BASE OF 5 INCH BRIDGE MASTS

DETAILS AND ASSEMBLIES

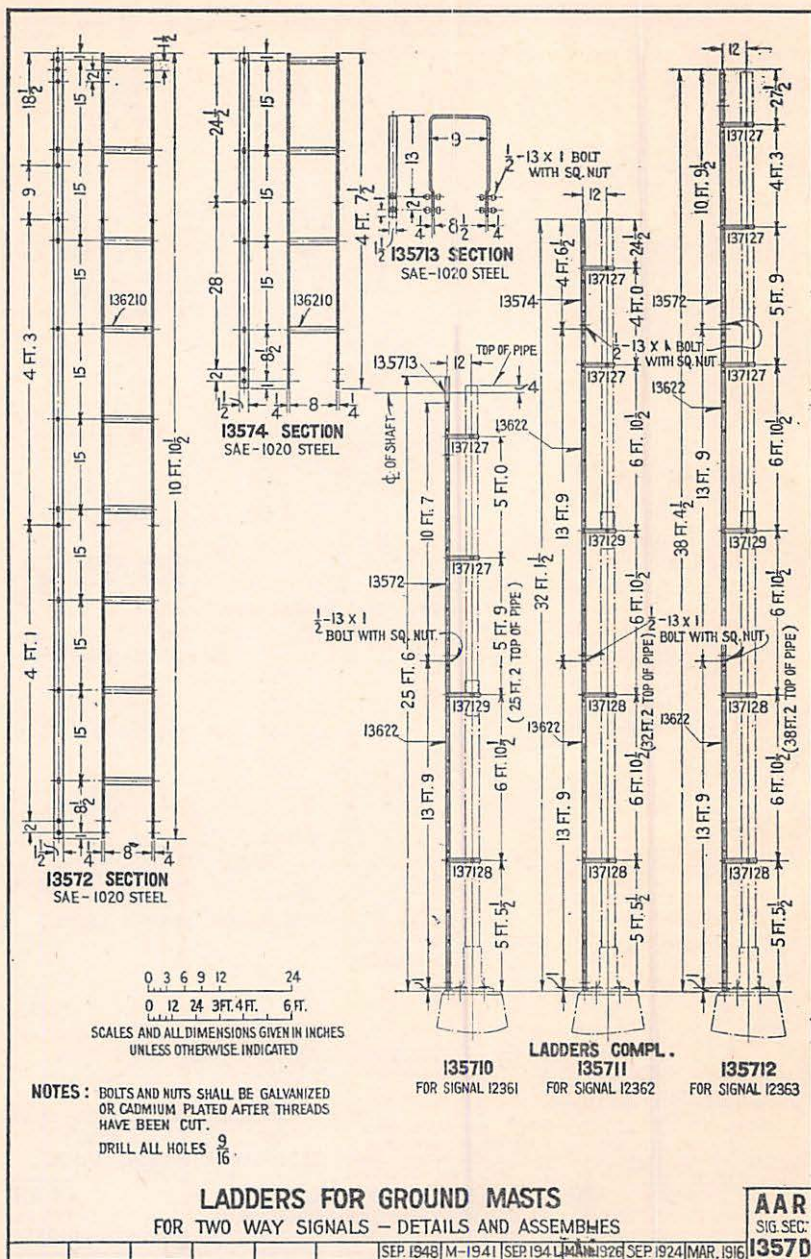
SEP. 1948 M-1945 OCT. 1945 M-1935 MAR. 1935 MANUAL- FEB. 1914 OCT. 1912

A.A.R.
SIG SEC
1178D

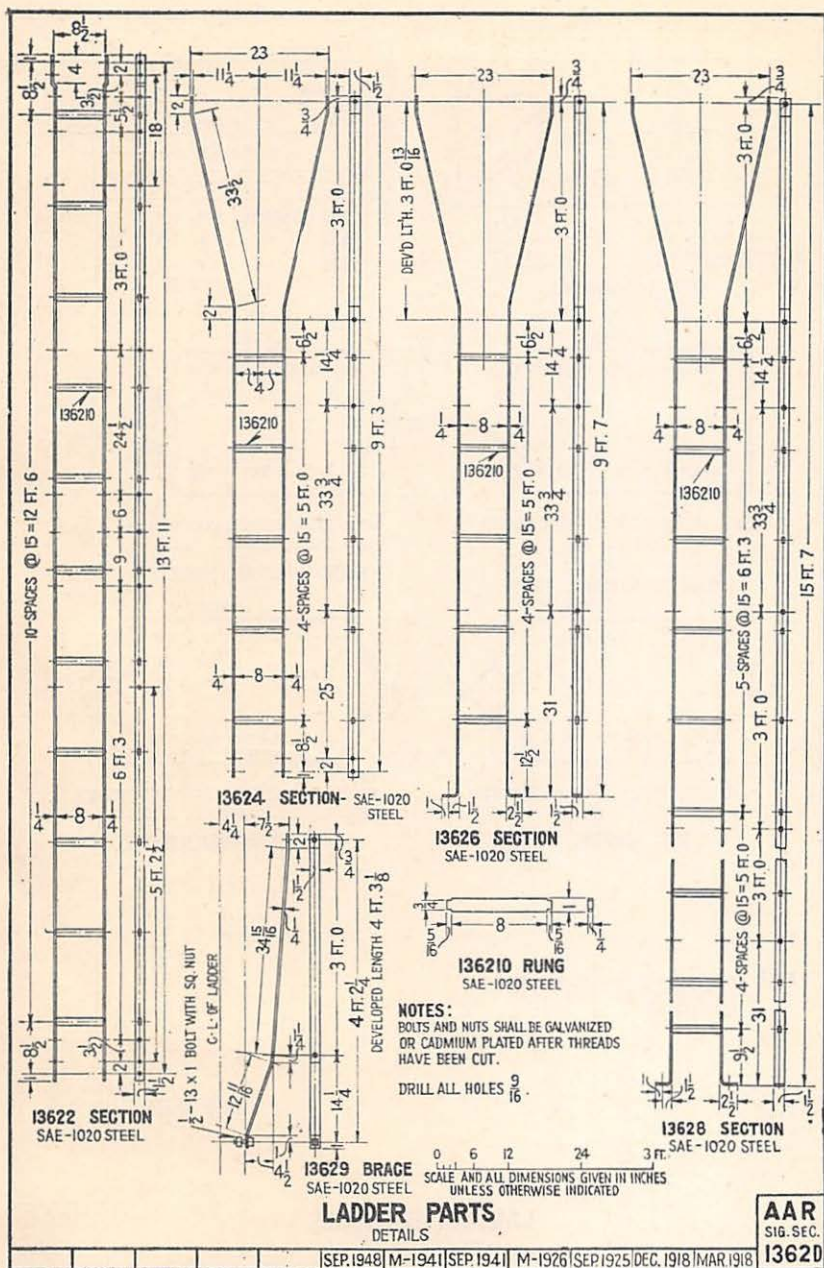
Cast iron shall be in accordance with Specification for Gray Iron Castings, Manual Part 88; Bolts, nuts and threads shall be in accordance with Specification for Bolts, Nuts and Threads, Manual Part 17; Painting shall be in accordance with Specification 120, Manual Part 110; Spring lock washers shall be carbon steel (A.S.A. current Specification B27.1 is preferred, where practicable).



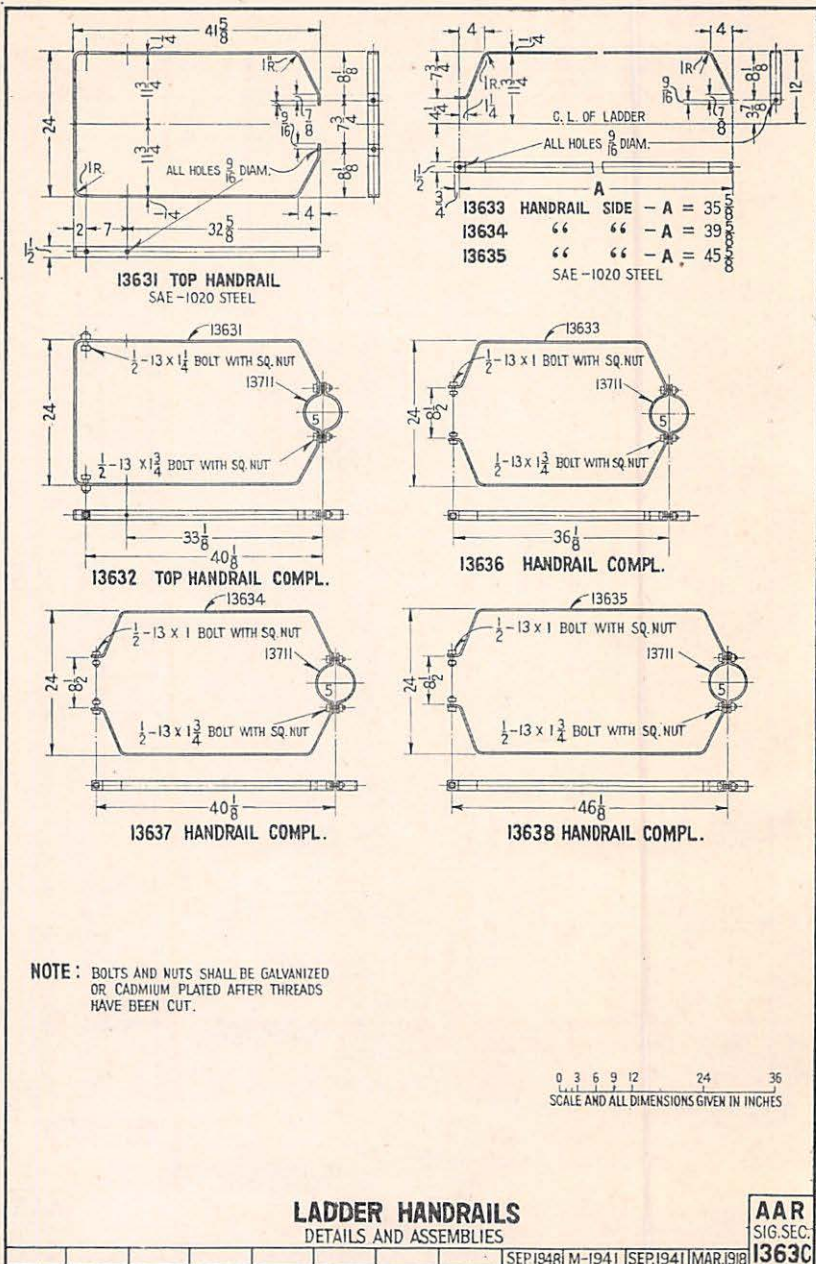
Cast iron shall be in accordance with Specification for Gray Iron Castings, Manual Part 88; Bolts, nuts and threads shall be in accordance with Specification for Bolts, Nuts and Threads, Manual Part 17; Painting shall be in accordance with Specification 120, Manual Part 110; Spring lock washers shall be carbon steel (A.S.A. current Specification B27.1 is preferred, where practicable).



Painting shall be in accordance with Specification 120, Manual Part 110;
Bolts, nuts and threads shall be in accordance with Specification for Bolts,
Nuts and Threads, Manual Part 17.



Painting shall be in accordance with Specification 120, Manual Part 110;
Bolts, nuts and threads shall be in accordance with Specification for Bolts,
Nuts and Threads, Manual Part 17.

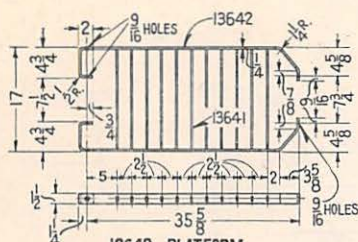


Painting shall be in accordance with Specification 120, Manual Part 110;
 Bolts, nuts and threads shall be in accordance with Specification for Bolts,
 Nuts and Threads, Manual Part 17.

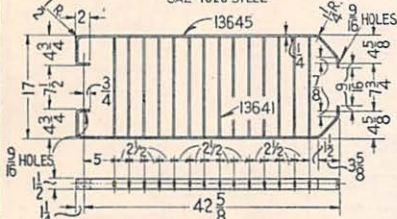
Sept. 1948]

0 3 6 9 12 24 36
SCALE AND ALL DIMENSIONS GIVEN IN INCHES

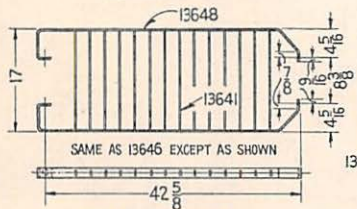
NOTE: BOLTS AND NUTS SHALL BE GALVANIZED
OR CADMIUM PLATED AFTER THREADS
HAVE BEEN CUT.



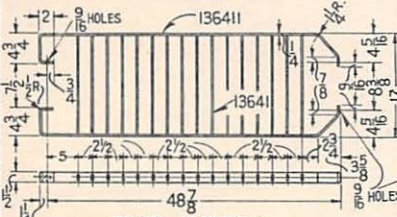
13643 PLATFORM
SAE-1020 STEEL



13646 PLATFORM
SAE-1020 STEEL



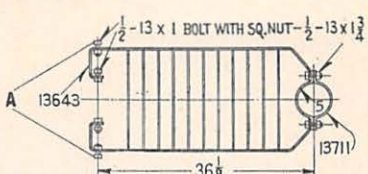
13649 PLATFORM
SAE-1020 STEEL



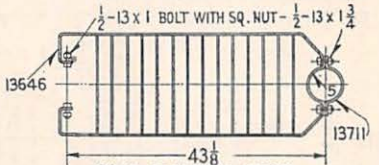
136412 PLATFORM
SAE-1020 STEEL



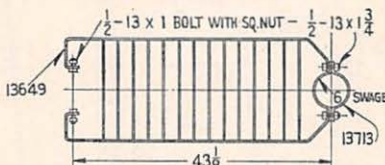
13641 PLATFORM RUNG
SAE-1020 STEEL



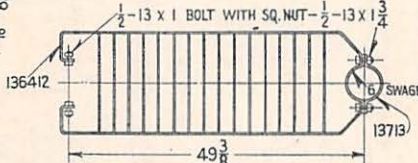
13644 PLATFORM COMPL.
BOLTS "A" REQUIRED FOR TOP PLATFORM ONLY



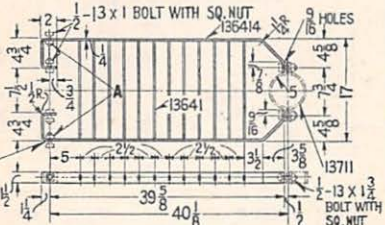
13647 PLATFORM COMPL.



136410 PLATFORM COMPL.



136413 PLATFORM COMPL.



136415 PLATFORM ONLY- SAE-1020 STEEL
136416 PLATFORM COMPL. WITH BOLTS & CLAMP
BOLTS "A" REQUIRED FOR TOP PLATFORM ONLY

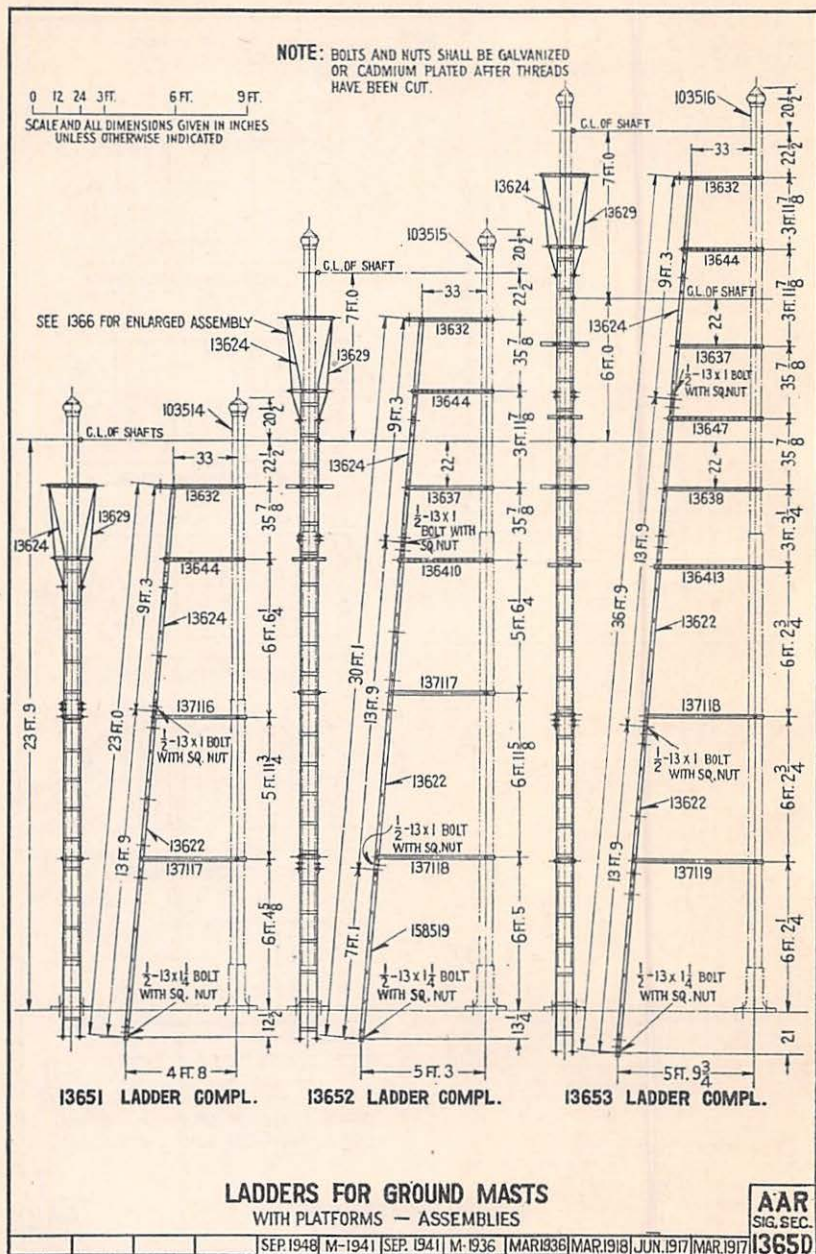
LADDER PLATFORMS DETAILS AND ASSEMBLIES

AAR
SIG. SEC.

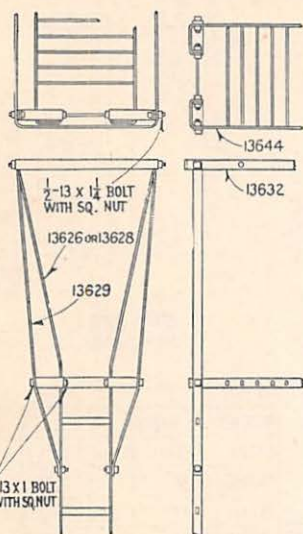
SEP. 1948 | M-1941 | SEP. 1941 | M-1934 | MAR. 1934 | MAR. 1918

1364D

Painting shall be in accordance with Specification 120, Manual Part 110;
Bolts, nuts and threads shall be in accordance with Specification for Bolts,
Nuts and Threads, Manual Part 17.

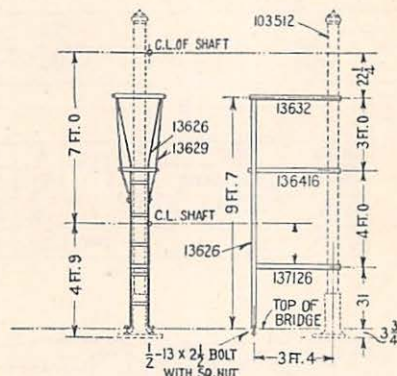


Bolts, nuts and threads shall be in accordance with Specification for Bolts, Nuts and Threads, Manual Part 17.

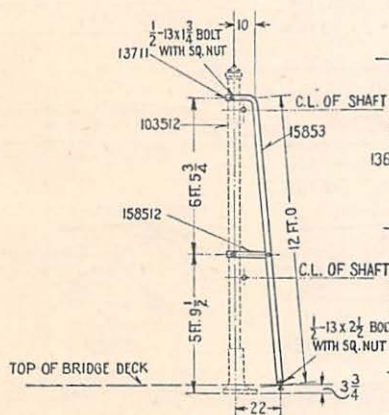


ENLARGED ASSEMBLY

NOTE: BOLTS AND NUTS SHALL BE GALVANIZED OR CADMIUM PLATED AFTER THREADS HAVE BEEN CUT.

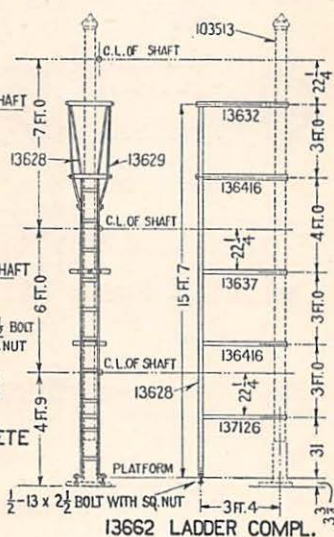


13661 LADDER COMPLETE



13663 LADDER COMPLETE

0 12 24 3 FT. 6 FT. 9 FT.
SCALES AND ALL DIMENSIONS GIVEN IN INCHES
UNLESS OTHERWISE INDICATED



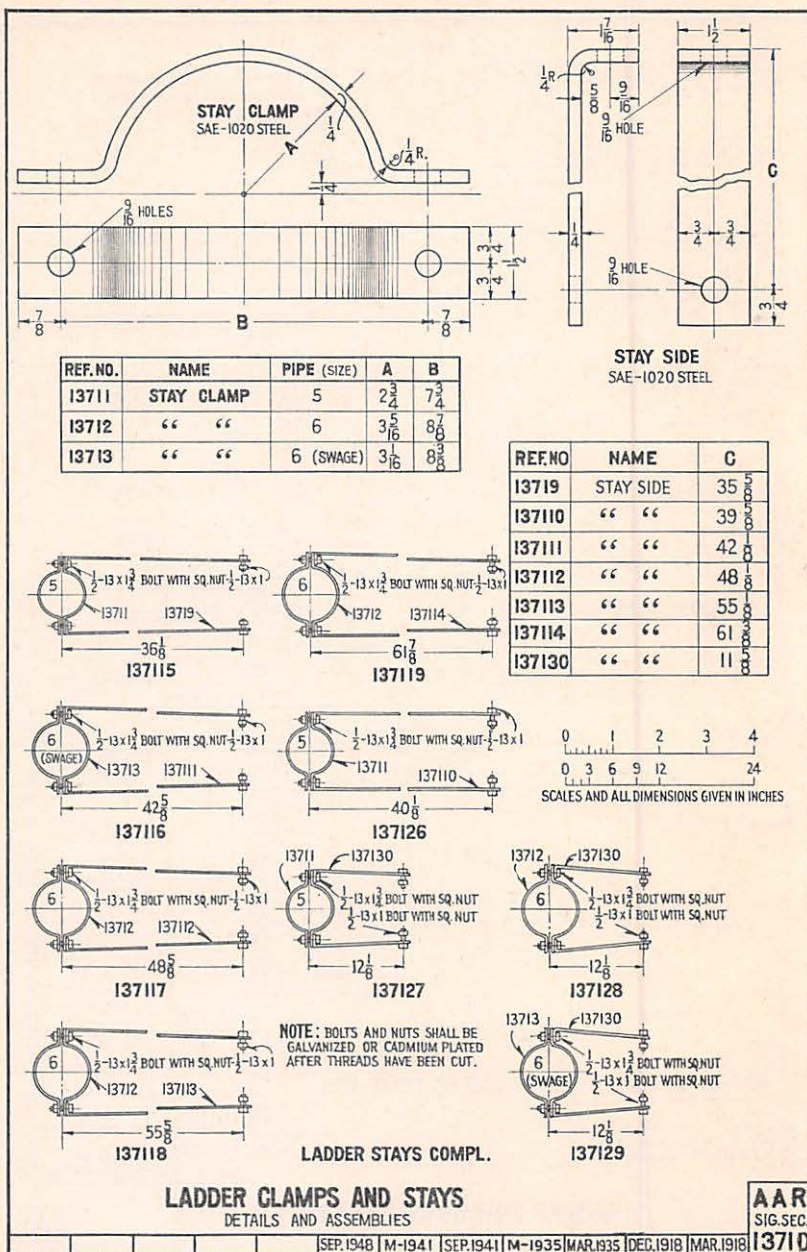
13662 LADDER COMPL.

LADDERS FOR BRIDGE MASTS ASSEMBLIES

AAR
SIG. SEC.
1366D

[SEP. 1948] M-1941 [SEP. 1941] M-1935 [MAR. 1935] MAR. 1918

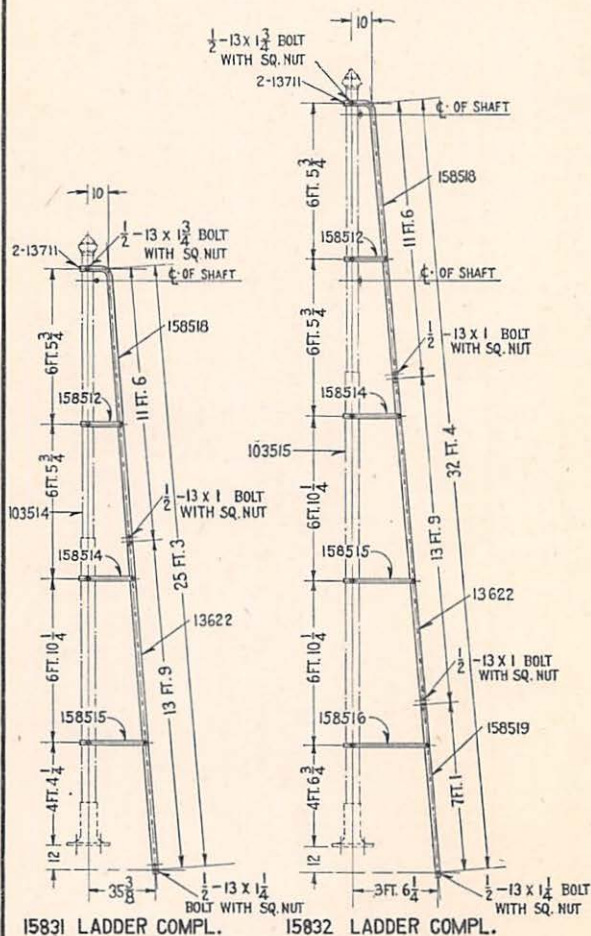
Bolts, nuts and threads shall be in accordance with Specification for Bolts, Nuts and Threads, Manual Part 17.



Painting shall be in accordance with Specification 120, Manual Part 110;
Bolts, nuts and threads shall be in accordance with Specification for Bolts,
Nuts and Threads, Manual Part 17.

0 12 24 3FT. 6FT. 9FT.
SCALE AND ALL DIMENSIONS GIVEN IN INCHES
UNLESS OTHERWISE INDICATED.

NOTE: BOLTS AND NUTS SHALL BE GALVANIZED
OR CADMIUM PLATED AFTER THREADS
HAVE BEEN CUT.

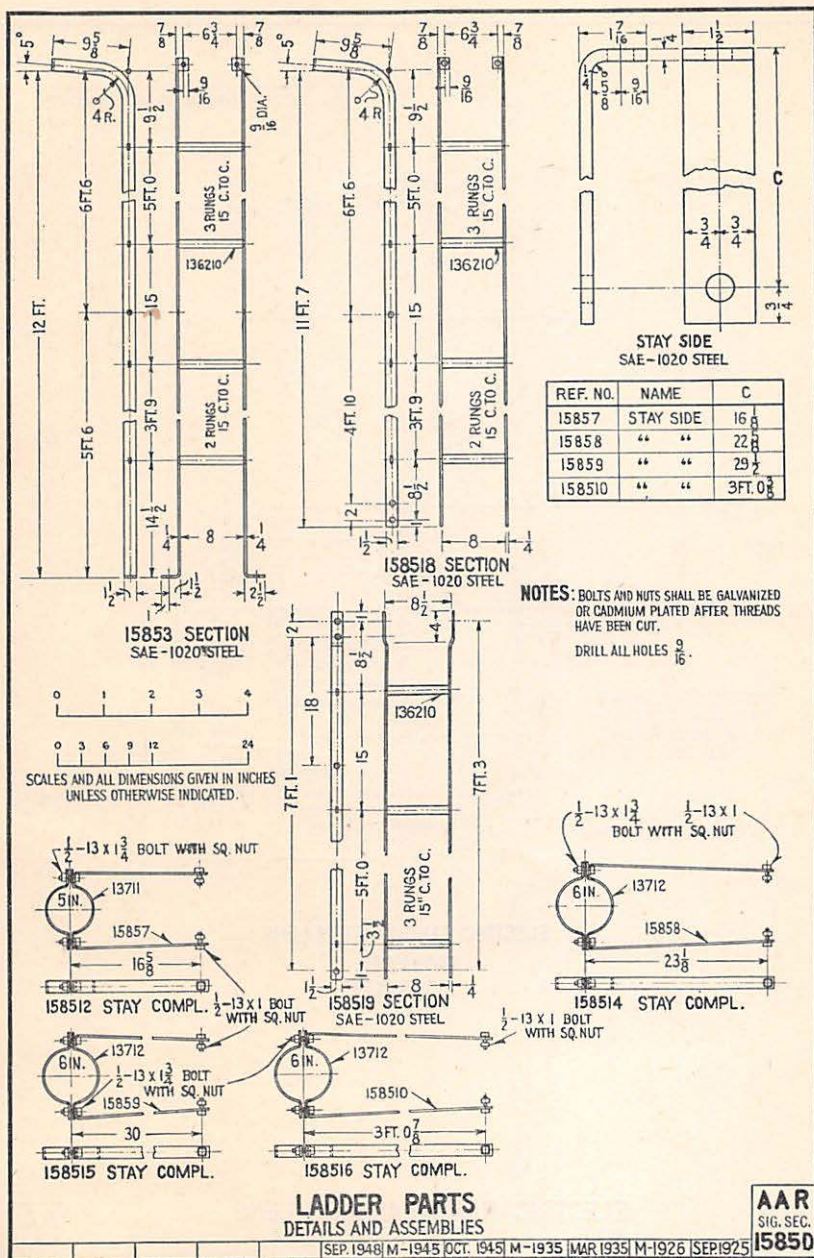


LADDERS FOR GROUND MASTS WITHOUT PLATFORMS—ASSEMBLIES

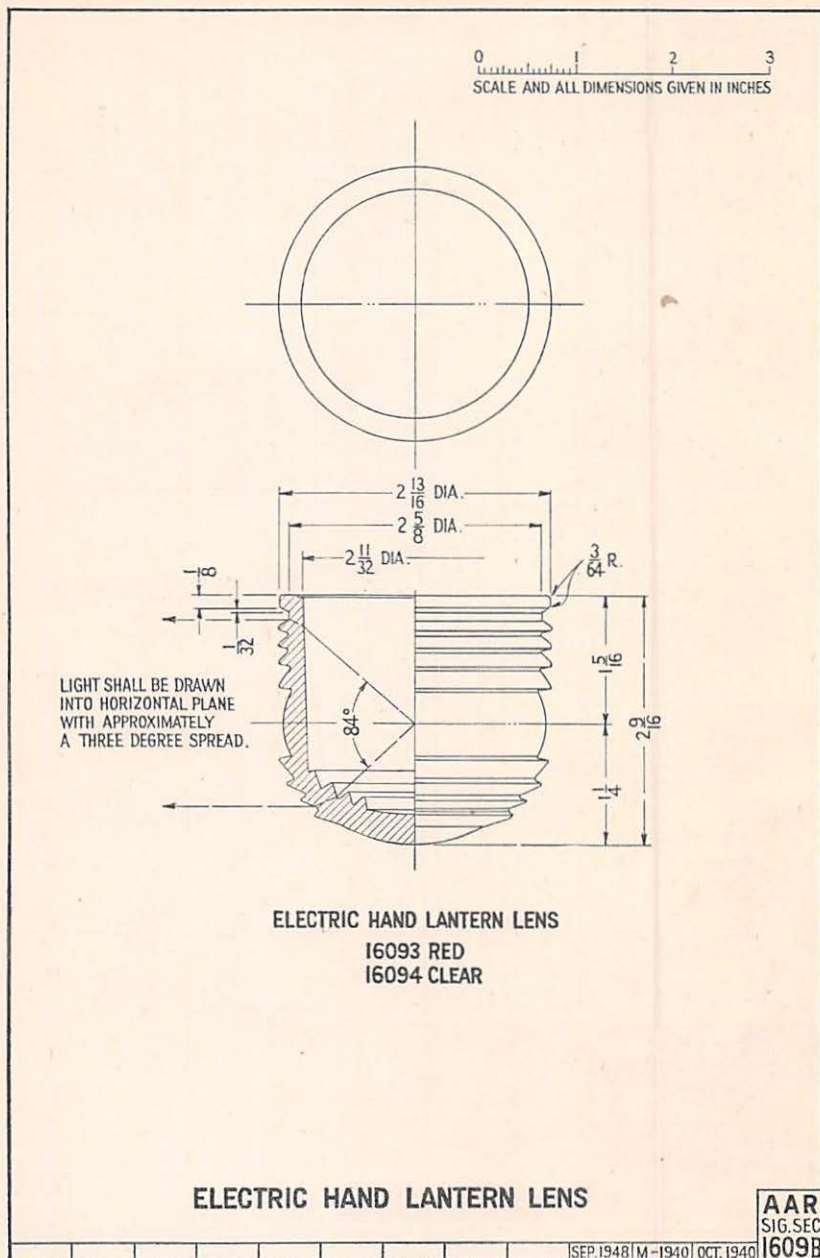
SEP. 1948 M-1945 OCT. 1945 M-1935 MAR. 1935 M-1926 SEP. 1925

AAR
SIG. SEC.
15830

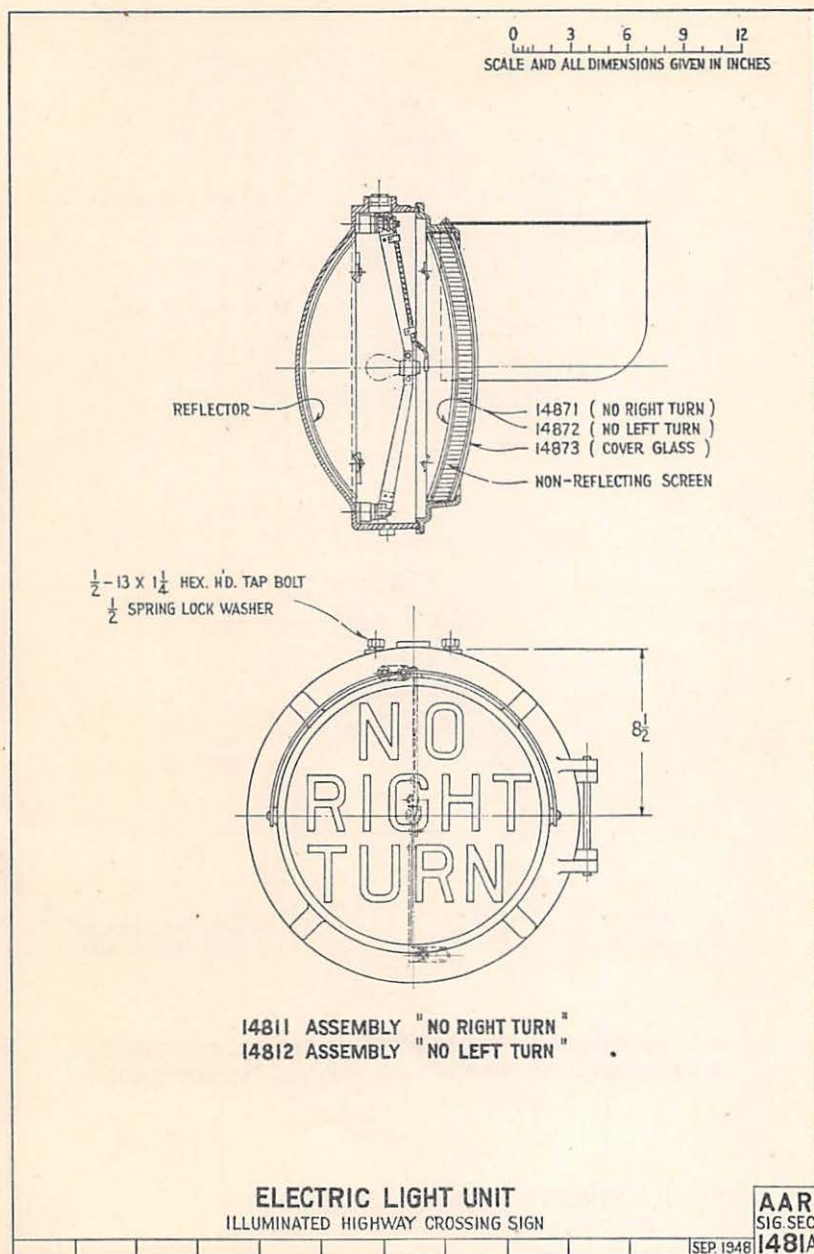
Bolts, nuts and threads shall be in accordance with Specification for Bolts,
Nuts and Threads, Manual Part 17.



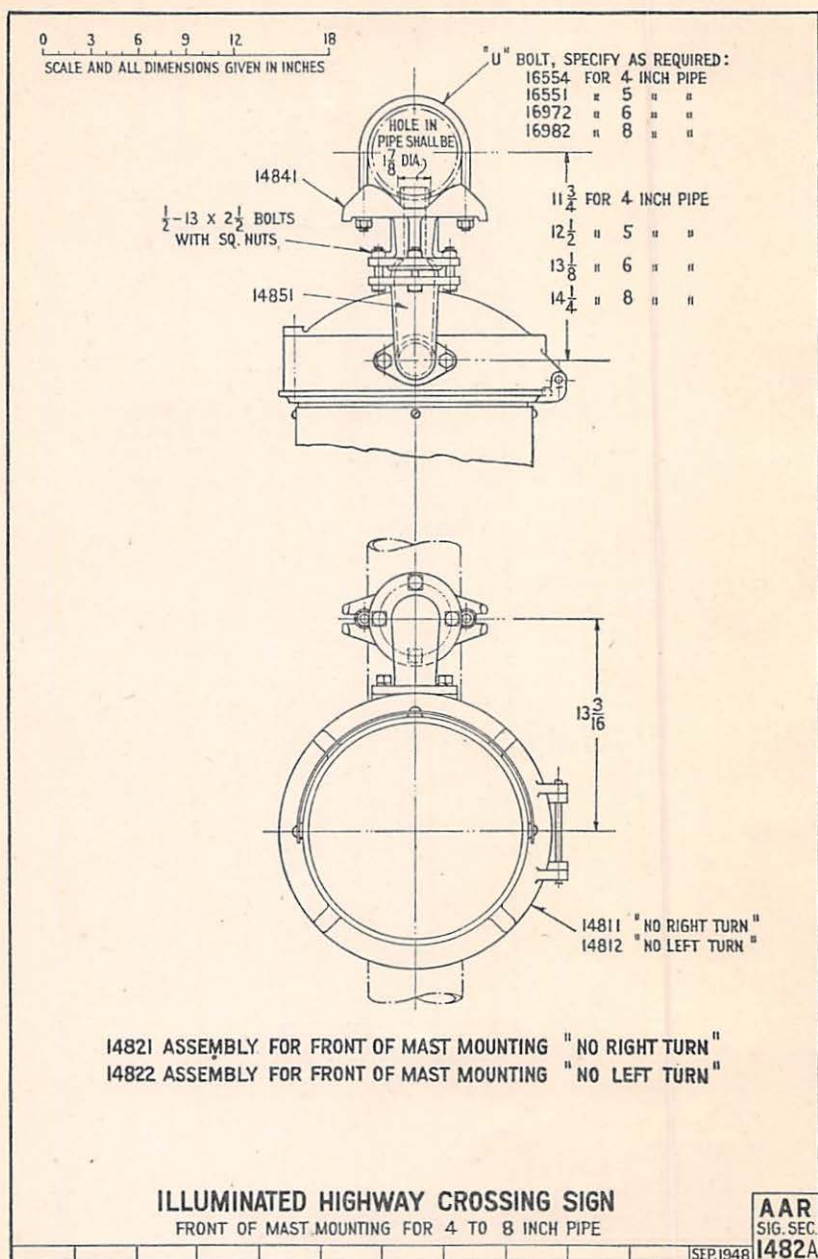
Painting shall be in accordance with Specification 120, Manual Part 110;
Bolts, nuts and threads shall be in accordance with Specification for Bolts,
Nuts and Threads, Manual Part 17.



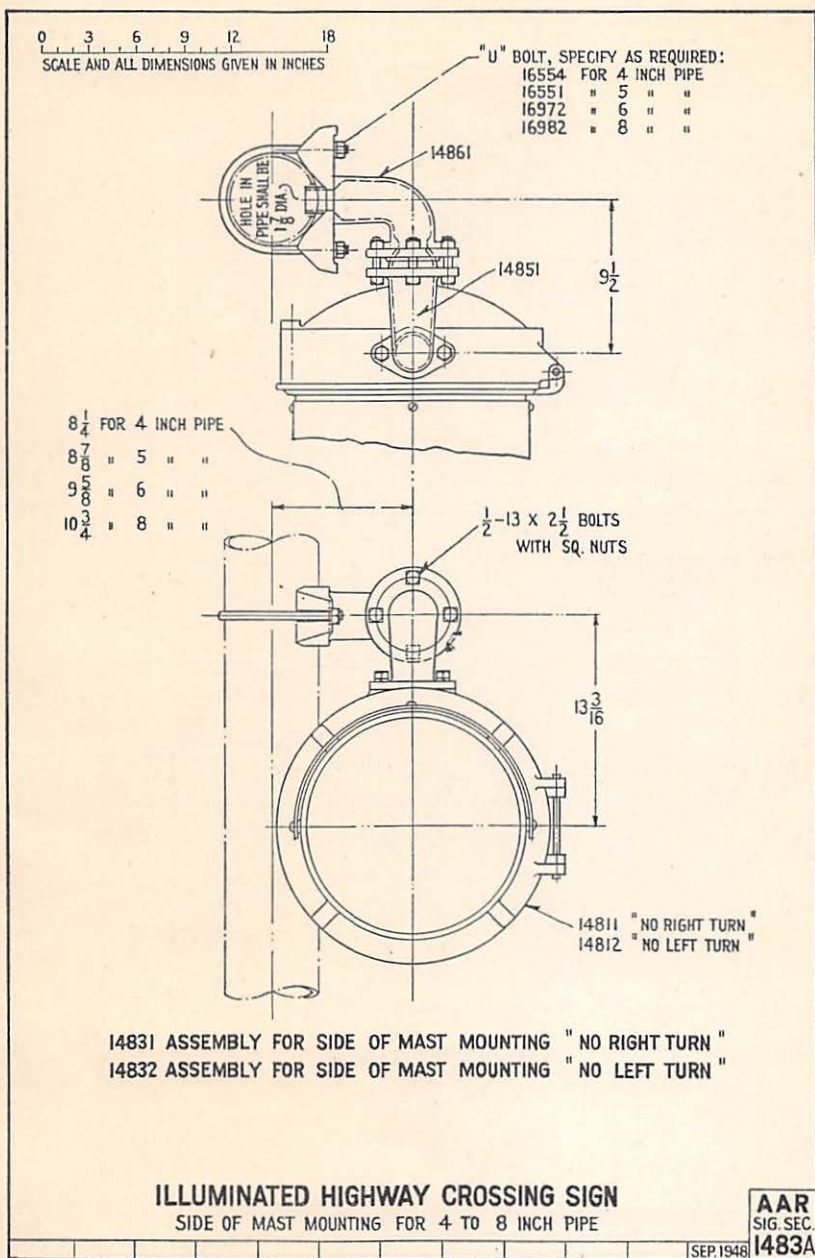
Material shall be in accordance with Specification 69, Manual Part 136.



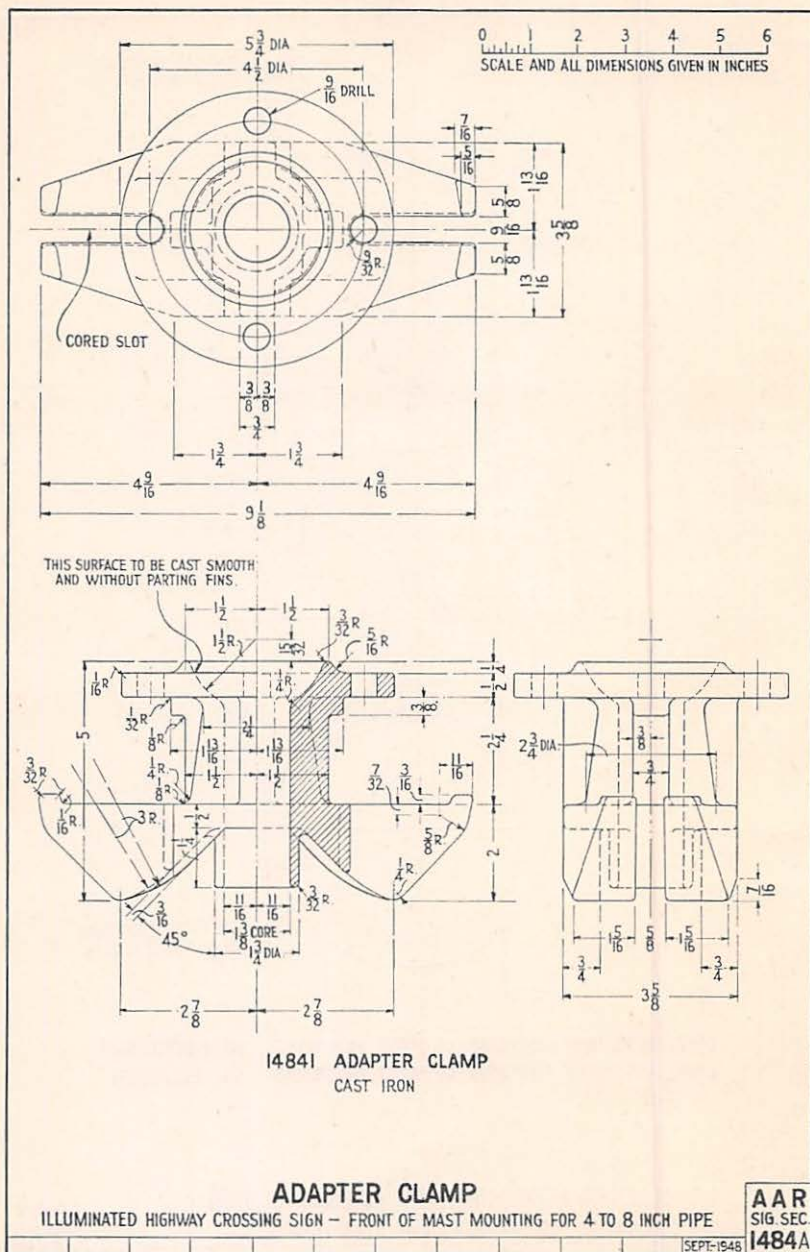
Unit shall be in accordance with Specification 231, Manual Part 237; Bolts, nuts and threads shall be in accordance with Specification for Bolts, Nuts and Threads, Manual Part 17; Spring lock washers shall be carbon steel (A.S.A. current Specification B27.1 is preferred, where practicable):

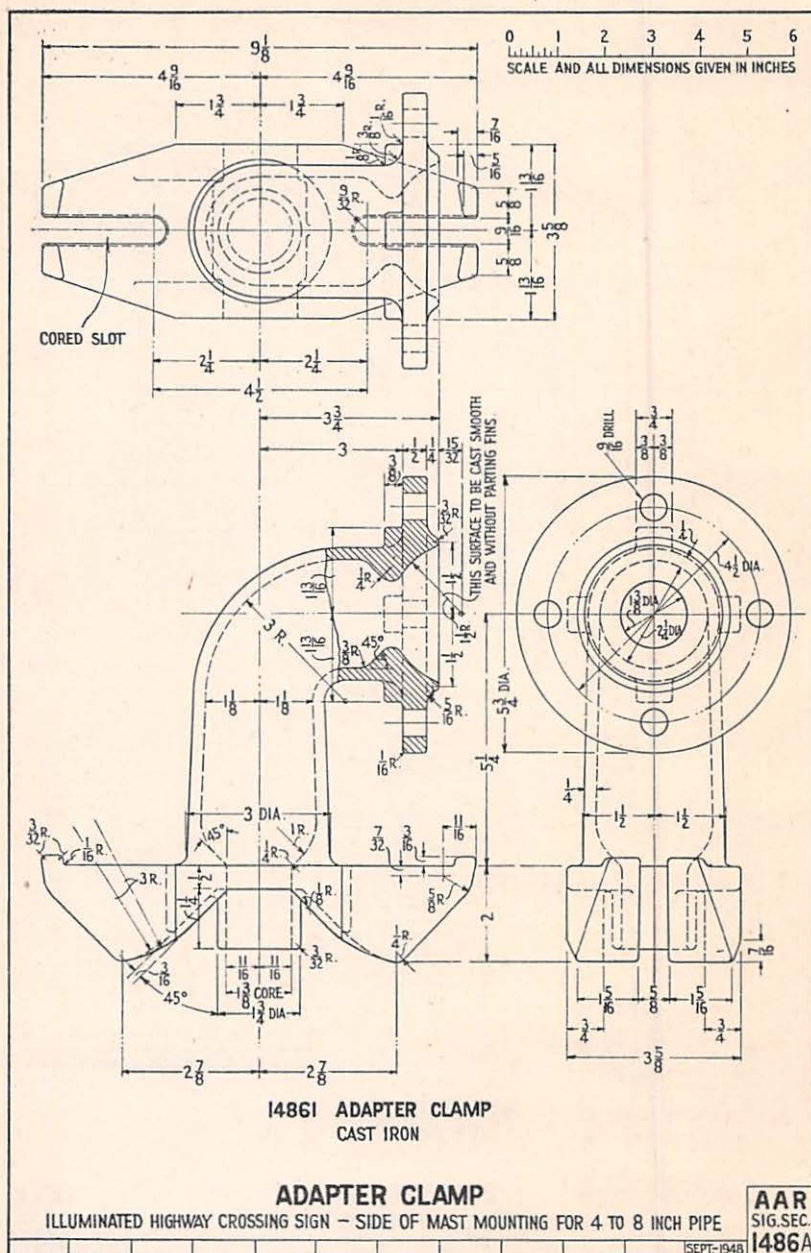


Sign shall be in accordance with Specification 231, Manual Part 237;
 Bolts, nuts and threads shall be in accordance with Specification for
 Bolts, Nuts and Threads, Manual Part 17.



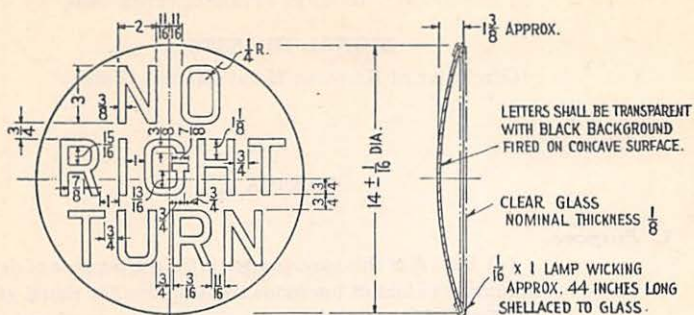
Sign shall be in accordance with Specification 231, Manual Part 237;
Bolts, nuts and threads shall be in accordance with Specification for
Bolts, Nuts and Threads, Manual Part 17.



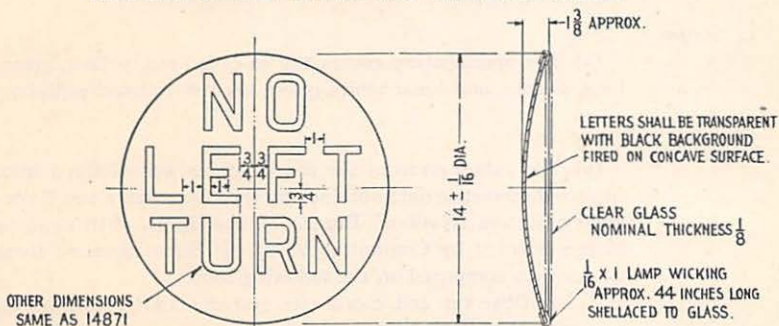


Cast iron shall be in accordance with Specification for Gray Iron Castings,
Manual Part 88.

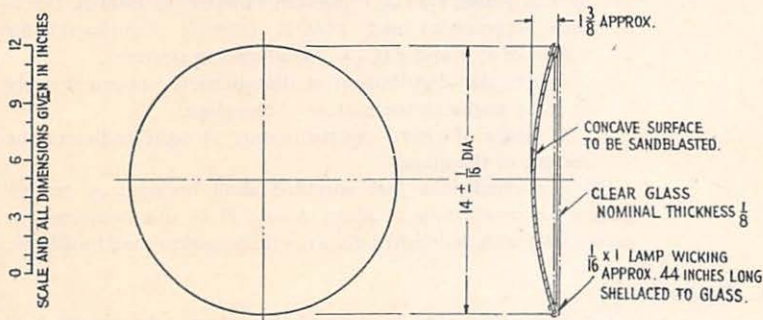
Sept. 1948]



14871 SIGN ROUNDEL "NO RIGHT TURN" COMPL. WITH WICKING



14872 SIGN ROUNDEL "NO LEFT TURN" COMPL. WITH WICKING



14873 COVER GLASS ROUNDEL COMPL. WITH WICKING

SIGN AND COVER GLASS ROUNDELS
ILLUMINATED HIGHWAY CROSSING SIGN

AAR
SIG. SEC.
1487A

SEP. 1948

(Revision of A.A.R. Signal Section Specification 69-40)
A.A.R. SIGNAL SECTION SPECIFICATION 69-48.

SIGNAL GLASSES

(Exclusive of Kerosene Hand Lantern Globes)

PART A

1. Purpose.

(a) Part A of this specification is for the purpose of defining the minimum values of luminous transmission for signal glasses and the limits of chromaticity for signal colors produced by illuminant-glass combinations.

2. Scope.

(a) The specification covers the so-called red, yellow, green, blue, purple, and lunar white colors used in railroad signaling.

3. Basis.

(a) The values given in the specifications were derived from spectrophotometric data obtained by the Photometry and Colorimetry Section, National Bureau of Standards, with defining glasses selected by Committee VI of the Signal Section; these values were computed on the following basis:

1. Observer and coordinate system: 1931 I.C.I. Standard. (See section 4.)

2. Illuminant: Planckian radiator at 2360°K for values of T_{AAR} and T_r/T_w , Planckian radiator at 1900°K (kerosene illuminant) and 2848°K (electric illuminant) for values of x , y and z ($C_2 = 14350$ micron degrees).

3. Angular distribution of illumination: approximately at right angles to the surface of the glass.

4. Angle of view: approximately at right angles to the surface of the glass.

(b) The conditions just specified shall be used in testing glasses for conformity to Parts A and B of this specification, except that with depolished discs the illumination shall be diffuse.

4. Explanatory.

(a) Any color can, in general, be adequately specified in terms of three colorimetric quantities. In the case of the signal colors the three quantities adequate for the purpose are two numbers defining the chromaticity of the color (*i.e.*, its hue and saturation) and one number defining the luminous transmission of the glass. Since no two observers would, in general, get the same numbers by direct observation (because of differences in luminosity function and chroma vision) it is desirable to express such numbers in terms of an hypothetical average normal observer. Such an observer was defined by resolutions

4. *Explanatory.*—Continued.

adopted at the 1931 meeting of the International Commission on Illumination at Cambridge (Proceedings, pp. 19-29). The chromaticity of a color expressed in terms of this 1931 I.C.I. Standard Observer is given by numbers x , y and z (called chromaticity coordinates), which may be considered as expressing roughly the respective red, green and blue contents of the color. Since the sum of x , y and z always equals unity, the chromaticity is adequately specified by giving any two of the numbers.

(b) The chromaticity of all colors may, therefore, be represented graphically on a chromaticity diagram with values of y plotted against values of x . Permissible values of chromaticity for the signal colors are represented by certain areas on this diagram; the boundaries of these areas may be expressed as functions of x , and either y or z . It may be emphasized that x , y and z refer to the chromaticity of the *illuminant-glass combination* and that a glass which meets the requirements with a given illuminant may not do so with a different illuminant.

(c) The luminous transmissions of the signal glasses are expressed on the AAR scale. This scale is defined in terms of the 1931 I.C.I. Standard Observer in the following table:

Color designation of glass	AAR transmission T_{AAR}	Equivalent luminous transmission, 1931 I.C.I. Standard Observer, Illuminant 2360°K
Red	100	0.069
Yellow	100	0.247
Green	100	0.119
Blue	100	0.0223
Purple	100	0.0129
Lunar white	100	0.190

(d) An additional specification is required to differentiate the blue and purple signals. In practice the principal difference between these two signal colors is not one of chromaticity, but is due to the fact that the purple glass gives a dichromatic signal, *i.e.*, red surrounded by blue, resulting from the chromatic aberration of the eye, whereas the blue glass, transmitting but little red light, gives only the blue signal color. This difference in the relative amounts of red light transmitted by the blue and purple glasses forms an essential part of the specification for these two signal colors. For this particular purpose, red light is defined to include the wave length range from 650 to 770m μ , and the proportion of the red to total luminous transmission is expressed by the ratio T_r/T_w .

5. *Red.*

(a) Four types of red glass are used: (1) pressed ware (except electric lantern and highway crossing), for which the value of T_{AAR} shall be not less than 85, (2) thin polished discs, for which the value of T_{AAR} shall be not less than 115, (3) electric lantern

5. *Red.*—Continued.

lenses, for which the value of T_{AAR} shall be not less than 140, and (4) highway crossing roundels, for which the value of T_{AAR} shall be not less than 220; in cases (1) and (2) the value of y shall be not greater than 0.287; in case (3) not greater than 0.295, and in case (4) not greater than 0.308, and in all four cases the value of z shall be not greater than 0.001.

6. *Yellow.*

(a) Two types of yellow glass are used: (1) the non-heat-resisting type, for which the value of T_{AAR} shall be not less than 130, and (2) the heat-resisting type, designed for use in thin discs with electric illuminant, which must have one surface depolished and for which the value of T_{AAR} need not be specified; in both cases the value of y shall be not greater than 0.429 nor less than 0.384, also not less than $0.864 - 0.783x$.

7. *Green.*

(a) Two types of green glass are used: (1) the non-heat-resisting type, for which the value of T_{AAR} shall be not less than 150, and (2) the heat-resisting type, designed for use in thin polished discs with electric illuminant, for which type the value of T_{AAR} shall be not less than 138; in both cases the value of y shall be not less than 0.400 nor less than $1.068x + 0.153$, and the value of z not less than 0.186.

8. *Blue.*

(a) The value of T_{AAR} shall be not less than 75; the value of x shall be not greater than 0.179, and the value of y not greater than $1.15x$; the value of T_r/T_w shall be not greater than 0.008.

9. *Purple.*

(a) Two types of purple glass are used: (1) that designed for use with kerosene illuminant, for which type the value of T_{AAR} shall be not less than 73 and the value of T_r/T_w not less than 0.116, and (2) that designed for use with electric illuminant, for which type the value of T_{AAR} shall be not less than 30 and the value of T_r/T_w not less than 0.187; in both cases the value of x shall be not greater than 0.228, and the value of y not greater than $1.505(x - 0.130)$, nor shall the value of T_r/T_w be greater than 0.240.

10. *Lunar white.*

(a) Three types of lunar white glass are used: (1) that designed for use with kerosene illuminant, for which the value of T_{AAR} shall be not less than 80; (2) pressed ware designed for use with electric illuminant, for which the value of T_{AAR} shall be not less than 147, and (3) the heat-resisting type in thin discs, which must have both surfaces depolished, designed for use with electric illuminant, and for which the value of T_{AAR} need not be specified; in all cases the value of x shall be not greater than 0.440 nor less than 0.330 and the value of y not greater than $0.51x + 0.183$ nor less than $0.51x + 0.172$.

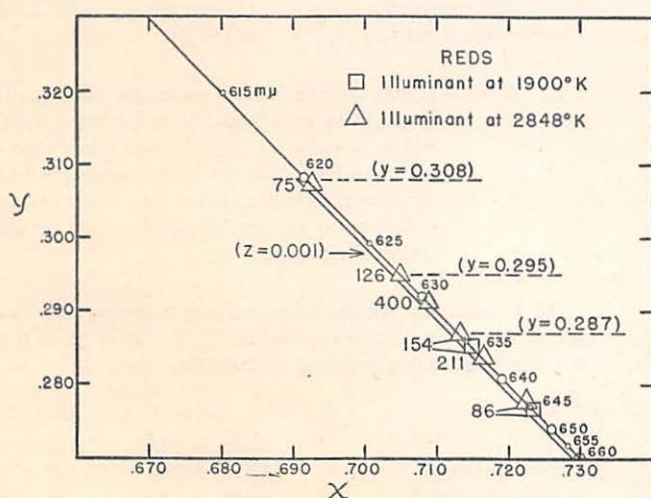
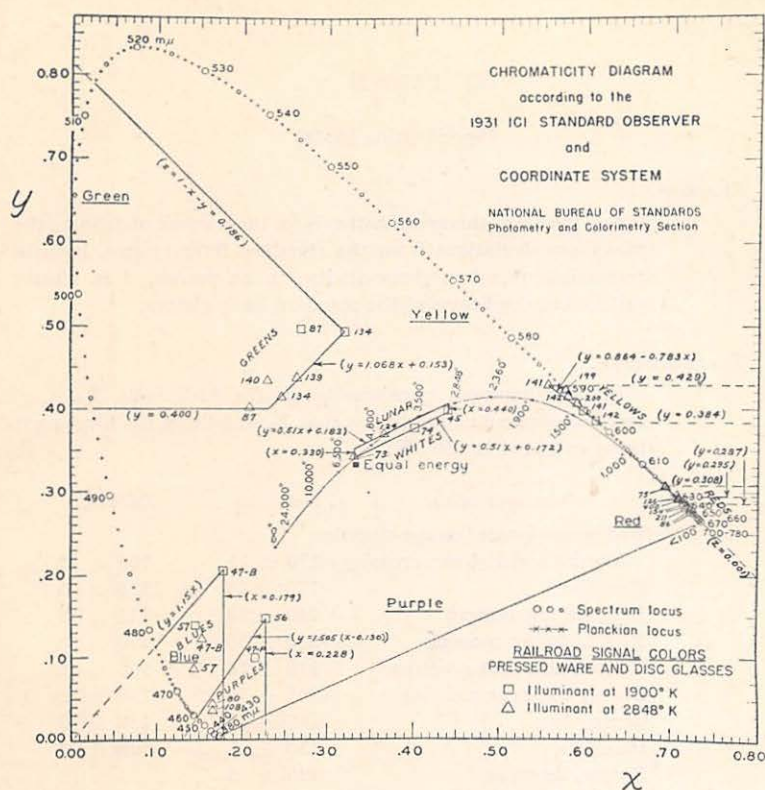


Diagram Illustrating Part A of Specification 69.

PART B

(Specification 69-48)

1. Purpose.

(a) Part B of this specification is for the purpose of defining the maximum deviations from the standard limit glasses, both in transmission and in chromaticity, to be permitted in glasses certified as duplicates of the standard limit glasses.

2. Transmission.

(a) The luminous transmissions on the AAR scale, T_{AAR} , of certified duplicate limit glasses shall be as follows, the illuminant being operated at 2360°K:

Color designation	Light limit	Dark limit
Red pressed ware (except electric lantern and highway crossing)	170 ± 15	100 ± 5
Red disc	170 ± 15	115 ± 5
Red, electric lantern	240 ± 20	145 ± 10
Red, highway crossing	310 ± 30	220 ± 20
Yellow, non-heat-resisting	215 ± 10	160 ± 5
Green, non-heat-resisting	205 ± 10	150 ± 5
Green, disc	190 ± 10	138 ± 5
Blue	130 ± 5	75 ± 3
Purple, kerosene	130 ± 5	73 ± 3
Purple, electric	40 ± 3	30 ± 2
Lunar white, kerosene	122 ± 5	80 ± 4
Lunar white, electric	200 ± 10	147 ± 5

Note.—It may be noted that in some cases a certified dark limit glass may have, in accordance with this table, a value of T_{AAR} slightly less than that given in Parts A and C of this specification; this does not, however, invalidate Parts A and C, which must be met by all glasses to be used in railroad signaling.

(b) In addition, for the blue and purple glasses, the ratio of red to total luminous transmission, T_r/T_w , shall be as follows, the illuminant being operated at 2360°K:

Color designation	Light limit	Dark limit
Blue	0.008 ± 0.001	0.000 to 0.001
Purple, kerosene	0.120 ± 0.010	0.160 ± 0.010
Purple, electric	0.190 ± 0.020	0.220 ± 0.020

3. *Chromaticity.*

(a) All certified duplicate limit glasses shall pass Part A of this specification with respect to the chromaticity coordinates, x , y and z ; they must also pass the additional specification given in Table I. In Table I are given first the values of x , y and z for the standard limit glass with the specified illuminant, followed by the maximum deviations from these values which are permitted in the certified duplicate glass. However, it is unnecessary to give permissible deviations for more than two of these three coordinates, since the sum of x , y and z is always unity.

TABLE I

Chromaticity Coordinates of Standard Limit Glasses and Permissible
Deviations from Such Values for Certified
Duplicate Limit Glasses

Color designation	Type	Limit	Standard limit glass No.		Chromaticity coordinates			Illuminant °K	Note
					x	y	z		
Red, pressed ware (except electric lantern and highway crossing)	disc	light	154	standard	0.7132	0.2867	0.0000	2848	a
		dark	86	std.	0.7224	0.2776	0.0000		
Red	disc	light	154	m.d.	±0.0008	±0.0008	0.0000	2848	b
		dark	86	m.d.	0.7132	0.2867	0.0000		
Red	electric lantern	light	126	std.	0.7224	0.2776	0.0000	2848	b
		dark	211	m.d.	±0.0025	±0.0025	0.0001		
Red (Highway crossing)	disc	light	75	std.	0.7050	0.2949	0.0001	2848	b
		dark	400	m.d.	±0.0008	±0.0008	0.0000		
Yellow	nonHR	light	141	std.	0.7165	0.2835	0.0000	2848	b
		dark	142	m.d.	±0.0008	±0.0008	0.0001		
Yellow	disc	green	199	std.	0.6927	0.3072	0.0001	2848	a
		red	200	m.d.	±0.0008	±0.0008	0.0001		
Green	nonHR	light	134	std.	0.7088	0.2912	0.0001	2848	a
		dark	87	m.d.	±0.0008	±0.0008	0.0149		
Green	disc	light	139	std.	0.5560	0.4291	0.0149	2848	bd
		dark	140	m.d.	±0.0010	±0.0010	0.0056		
Blue	disc	light	47B	std.	0.5794	0.4151	0.0056	2848	be
		dark	57	m.d.	±0.0010	±0.0010	0.0012		
Purple	kerosene	light	56	std.	0.5762	0.4226	0.0012	2848	be
		dark	47P	m.d.	±0.0010	±0.0010	0.0038		
Purple	electric	light	80	std.	0.5889	0.4073	0.0038	2848	bg
		dark	108	m.d.	±0.0010	±0.0010	0.0038		
Lunar white	kerosene	light	45	std.	0.2448	0.4145	0.3407	1900	a
		dark	74	m.d.	±0.0015	±0.0015	0.3899		
Lunar white	electric	light	124	std.	0.2084	0.4016	0.3899	1900	cf
		dark	73	m.d.	±0.0015	±0.0015	0.3899		

- a. Glasses give signal colors passing Part A of this specification with either electric (2848°K) or kerosene (1900°K) illuminant.
 b. Glasses designed for electric illuminant only.
 c. Glasses designed for kerosene illuminant only.
 d. If used with kerosene illuminant, the red limit glass will give a signal color too red to pass Part A of this specification.
 e. If used with kerosene illuminant, these glasses will give signal colors too yellow to pass Part A.
 f. If used with electric illuminant, these glasses will give signal colors too blue to pass Part A.
 g. If used with kerosene illuminant, these glasses will give signal colors too red to pass Part A.

PART C

(Specification 69-48)

1. Purpose.

(a) Part C of this specification is for the purpose of providing approved roundels, lenses, discs, and slides for railroad signaling, to describe the materials, and specify the appliances and appurtenances necessary to make the required tests and inspection. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. Materials.

(a) General.

1. Quality and processing shall be of the best for the purpose. The composition must be durable on prolonged exposure to weather; all glasses shall be true to size and form, free from any streaks, wrinkles, chips or bubbles that in any way detract from their efficiency or use. Colored glasses shall be uniformly colored; flashed glasses will not be accepted.

(b) Design.

1. Roundels.

(a) Roundels shall be of the convex type and be between 0.21 and 0.29 inch in thickness.

2. Polished discs.

(a) Polished discs of 1 in. diameter shall be between 0.059 and 0.065 inch in thickness.

Note.—Discs will be furnished depolished on one side or both sides, if so specified.

3. Slides.

(a) Slides shall be $\left\{ \begin{array}{c} \text{cut} \\ \text{pressed} \end{array} \right\}$ to the size ordered, and be between 0.15 and 0.095 inch in thickness.

4. Lenses.

(a) Lenses shall be polyzonal and may be of the following designs or equivalent, according to requirements:

1. Optical—single or double element, each element having one smooth surface.

2. Spreadlight—of the optical design with fluted outer surface for spreading the light either horizontally or horizontally and vertically.

3. Fresnel or multi-fresnel.

Note.—Plano-convex lenses will have both convex and flat surfaces smooth. Sizes larger than 2 inches in diameter shall have the flat surface polished.

3. Apparatus and appurtenances for testing.

(a) Certified limit glasses.

1. Certified light and dark limit glasses, calibrated by the National Bureau of Standards, Washington, D. C., shall be made available by the Seller for use of the Purchaser while conducting tests. These certified glasses shall serve to define both the proper luminous transmissions of the glasses to be tested and the proper chromaticities of the resulting signal colors as hereinafter provided.

(b) Photometer.

1. An approved photometer shall be made available by the Seller for use of the Purchaser while conducting tests. The illuminant used for measurements shall have a color temperature between 2360°K and 3000°K , and with no samples in the beams the two halves of the photometric field shall have the same chromaticity.

Note:

1. Vacuum tungsten lamps or gas-filled tungsten lamps with white bulbs should give the specified color temperature, if operated at normal voltage.

2. The 1908 specification established spectrophotometric values for a glass in each of the six colors, having a chromaticity and a transmission value approximately midway between the respective values for the light and dark limits. Each of these glasses was given an arbitrary value of 100 per cent for use as a standard in laboratory and routine photometry. By means of these standard glasses, the present photometric scale for measuring the transmission of all colored signal glasses was established. This practice is continued except that the 100 per cent pressed standards have been superseded by the standard limit glasses in the form of 2 in. polished squares.

4. Tests and inspection.

(a) The Manufacturer must test each glass and place thereon a label which shall indicate that the glass has been tested and meets the requirements of this specification.

(b) The Seller shall give sufficient notice of the time when glasses are ready, provide at his place of test all apparatus and appurtenances and supply labor necessary to make the required tests and inspection.

(c) The Purchaser may make such inspection of glasses as to assure him that the requirements of this specification have been met.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

4. *Tests and inspection.*—Continued.

(e) Transmission test.

1. The Purchaser shall measure the transmission T_{AAR} of each glass, using the above specified photometer and illuminant and respective certified limit glasses whose values of T_{AAR} are engraved thereupon. A glass shall not be acceptable whose value of T_{AAR} is less than the respective minimum value given in the following table:

Table of Minimum Values of Luminous Transmission
on the AAR Scale, T_{AAR}

Color designation	Pressed lenses and roundels, and cut or pressed slides	Polished flat discs
Red (except electric lantern and high- way crossing)	85	115
Red, electric lantern	140	(not used)
Red, highway crossing	220	(not used)
Yellow	130	(Depolished on one side)
Green	150	138
Blue	75	75
Purple (kerosene)	73	(not used)
Purple (electric)	(not used)	30
Lunar white (kerosene)	80	(not used)
Lunar white (electric)	147	(Depolished on both sides)

Note.—Either of the following additional tests shall be applied to the blue and purple glasses: (1) A red glass (approximately equivalent to the dark limit red glass) shall be placed over the eye-piece of the photometer. The transmission of blue glasses for this red light shall be not greater than that of the light limit blue glass, and similarly the transmission of purple glasses for this red light shall be not less than that of the dark limit purple glass; or (2) an incandescent lamp shall be viewed through a red glass (approximately equivalent to the dark limit red glass). The test glass and the limit glass, placed edge to edge, shall be rapidly alternated in position in the beam between the lamp and the eye. The transmission of the blue glasses so examined (for red light) shall appear not greater than that of the light limit blue glass, and similarly the transmission of purple glasses so examined (for red light) shall appear not less than that of the dark limit purple glass.

(f) Chromaticity test.

1. The Purchaser shall compare the chromaticity of each glass with that of the respective certified limit glasses, using for this purpose the above specified photometer and illumi-

4. Tests and inspection.—Continued.

nant. The comparisons shall be made with brightnesses matched. A glass shall not be acceptable if its chromaticity fails to meet either of the following requirements:

(a) The hue shall be not outside the hue limits given by the respective certified limit glasses; except that (1) for red glasses, only the yellow limit need be tested, and (2) for disc green glasses, the blue limit shall be given by the dark limit pressware (non-heat-resisting) green glass.

(b) The saturation shall be not less than that given by the respective certified light limit glasses; except that, for lunar white glasses, the saturation shall be not outside the saturation limits given by the respective certified limit glasses.

(g) The Purchaser reserves the right to make tests and inspection at destination, and if upon completion of such tests and inspection the glasses do not meet the specification, they may be rejected and returned at the Seller's expense for all freight charges, or otherwise disposed of as directed by the Seller.

(h) Rehearing.

1. When tests and inspection are made at the Purchaser's laboratory, such glasses as are rejected will be held for one month from date report is mailed to the Seller. If the Seller is dissatisfied, he may claim rehearing within the one month period. Failure to claim a rehearing will be evidence of his satisfaction with the report and the rejected glasses may be scrapped.

5. Marking.

(a) Certified limit glass marking.

1. Each certified limit glass (2 in. square or 1 in. diameter disc) shall be permanently engraved with the serial number by the maker and further permanently engraved by the National Bureau of Standards with the serial number, the designation, the value of T_{AAR} , the N.B.S. test number, and the date.

Note.—In all cases, the engravings may be verified, and additional information regarding the certified limit glasses obtained, from the N.B.S. Certificates for the glasses which shall be made available to the Purchaser by the Seller.

(b) Manufacturer's marking.

1. Each glass, except 1 in. discs, shall have pressed in its outer zone or flange, the name or trade-mark of the Manufacturer, the diameter and other designations needed for correct application such as focal length, toric or half-toric for lenses.

2. Each lens or roundel, except 1 in. discs, shall have a label showing that the T_{AAR} value exceeds the minimum

5. *Marking.*—Continued.

approved value, and in addition the blue, purple, lunar white and highway crossing red ("Hwy Xing") glass shall have the name of the color marked on this label, or etched on the glass.

(c) Seller's marking.

1. Purchaser's order and requisition number, name of Consignor, and name and address of Consignee, shall be plainly marked on the outside of each package.

6. *Wrapping.*

(a) Each glass, except 1 in. discs, shall be either:

1. Wrapped in paper of corresponding color, except for blue, purple, lunar white and highway crossing red glass which shall have white wrapper with the name of the color stamped on the outside of the wrapper; or,

2. Packed in cartons with either paper or corrugated sheets placed between each glass, and the quantity, size, and color stamped on the outside of the carton.

(b) Glass discs of 1 in. diameter shall be wrapped in packages of not more than 10 discs, with a layer of paper between each disc, and wrapped with either:

1. Paper of corresponding color, except for blue, purple, and lunar white, which shall be white with the name of the color stamped on the outside of the wrapper; or

2. White paper with each color stamped on the outside.

(c) All glass shall have the wrappers, or cartons where used, stamped "1935 A.A.R." on the outside.

(d) Material shall be so packed as to permit convenient handling and to prevent loss or damage during shipment.

(e) Detail list of loose pieces, containers and their contents shall be furnished for each shipment.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 69-40—Signal Glasses, Manual Part 136.

USE OF SAFETY NUTS IN SIGNAL APPARATUS

A questionnaire was sent to 146 Voting Representatives of Member Roads in the Signal Section on September 9, 1947 for the purpose of determining the different types of safety nuts in use in signal departments, their extent, manufacturers, whether adopted as standard, or test and results obtained.

Replies were received from 79 railroads, 72 of which reported no safety nuts in service.

A summary of the replies received from the 7 railroads reporting safety nuts in service is as follows:

Seven railroads reported seven different types of safety nuts in service, totalling 11,348, as manufactured by six different companies.

Two railroads reported having adopted as standard three different types of safety nuts now in use, on three different types of application. Five railroads reported safety nuts now in service on test and no standard has been adopted.

Three railroads reported using 8,312 safety nuts on car retarder brake shoes. Five railroads reported using 392 safety nuts on switch layouts. One railroad reported using 2,500 safety nuts for fastening electric switch heater elements to web of rail. One railroad reported using 144 safety nuts on adjustable rail braces.

Seven railroads reported 10 installations of safety nuts, made in the following months and years:

- 1 installation of 2,500 safety nuts made in 1937
- 1 installation of 144 safety nuts made in November 1938
- 1 installation of 36 safety nuts made in September 1940
- 2 installations of 7,328 safety nuts made in December 1941
- 1 installation of 1,000 safety nuts made in August 1944
- 1 installation of 100 safety nuts made in April 1946
- 2 installations of 40 safety nuts made in February 1947
- 1 installation of 200 safety nuts made over a period of 6 years

Six railroads reported torque wrench was not used while the seventh railroad did not indicate on questionnaire whether or not torque wrench was used.

Seven railroads reported as follows as to the efficiency of the safety nuts now in service:

- 1 railroad reported satisfactory to date
- 1 railroad reported very satisfactory
- 1 railroad reported very good
- 1 railroad reported good
- 1 railroad reported the use of safety nuts has reduced the maintenance of tightening shoe bolts on car retarders
- 1 railroad reported safety nuts satisfactory on rail braces but locking pin burrs and breaks where frequent adjustment is necessary. The type in service on rail braces is not suitable for general use on interlockings or car retarders. The same railroad also reported a second type safety nut used on car retarders and originally no lock washers were used, but due to frequent replacement of brake shoes it was found necessary to use lock washer ahead of nut.
- 1 railroad did not indicate on the questionnaire the efficiency of the safety nuts in service.

Action Recommended

Acceptance as information.

A.A.R. SIGNAL SECTION SPECIFICATION 232-48.

ELECTRIC LIGHT UNIT FOR HIGHWAY CROSSING SIGNAL
DOUBLET LENS TYPE1. *Purpose.*

(a) This specification is for the purpose of providing an electric light unit of the doublet lens type for highway crossing signals. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Detail design of unit shall be approved by Purchaser.

(b) Like parts of same Manufacturer's apparatus shall be interchangeable.

(c) Case and door or doors shall be cast iron, in accordance with A.S.T.M. current Specification A 48, Class 20. *R-6-c.

(d) Case shall be designed to house in a fixed position an $8\frac{3}{8}$ in. diameter doublet lens assembly and associated parts together with a suitable roundel as a cover glass to produce the required beam spread.

(e) Case shall be designed for attachment to cross-arm assembly, Drawing 1656, with suitable door or doors on the side or sides of the case.

(f) Two side light openings not less than $1\frac{1}{2}$ in. nor more than 2 inches in diameter, with hoods, and clear glass, shall be pro-

* Alternate requisites section.

6. Design.—Continued.

vided so that light from the lamp bulb can be directed along the horizontal axis of the unit 90 deg. away from the main indication.
*R-6-f.

(g) Case body shall project not more than $3\frac{1}{2}$ in. to the rear of the center line of the supporting fixture.

(h) Case shall be so designed that the center of the lenses and side lights shall be not less than $7\frac{1}{4}$ in. nor more than $9\frac{3}{4}$ in. below the center of cross-arm.

(i) Doors, roundels and lenses, shall be provided with durable waterproof gaskets which shall be fastened securely in place to prevent the entrance of dust or moisture.

(j) Case shall be so designed that the lenses, roundels and associated parts may be cleaned without disturbing the adjustment of the optical system.

(k) Door or doors shall provide:

1. Means for compressing the doors against the housing.

2. A locking lug with a minimum opening of $\frac{1}{2}$ in. for application of a lock.

3. Easy access to all parts when open.

(l) Machine screws, washers, bolts, nuts and hinge pins shall be of corrosion-resisting metal or suitably plated after threads have been cut. Zinc or cadmium shall not be used on parts carrying current.

(m) A breather opening with suitable filter shall be provided at bottom of case.

(n) Means shall be provided in the design for accurate alignment of the projected light beam to a predetermined point on the highway.

7. Terminals and wiring.

(a) Terminals in the case shall be conveniently located.

(b) Flexible copper wires not less than No. 18 A.W.G. single-conductor, suitably insulated, shall be provided when required between lamp receptacle and terminals and be securely fastened to prevent breakage.

(c) Wire eyelets or connectors shall be provided on each wire attached to binding posts.

8. Lenses and roundels.

(a) Lenses and roundels shall be in accordance with Specification 69, Manual Part 136.

(b) Lenses shall be of the doublet type, outer lens clear optical, $3\frac{3}{8}$ in. diameter, 4 in. focal length; inner lens, highway crossing red, $5\frac{1}{2}$ in. diameter. The focal length of the combination shall be $\frac{1}{2}$ in.

* Alternate requisites section.

8. *Lenses and roundels.*—Continued.

(c) Roundels shall be $8\frac{3}{8}$ in. diameter, convex, clear, and as specified by Purchaser, with range pattern per sections 11-c and 11-d, as follows (*R-8-c):

1. Thirty deg. horizontal spreadlight type with 15 deg. downward deflection.
2. Seventy deg. horizontal spreadlight type without downward deflection.
3. Twenty deg. horizontal spreadlight type with 32 deg. downward deflection.
4. Diffusion-deflection roundel, with horizontal and downward spread.

(d) Means shall be provided for replacement of cover glass without disturbing the optical adjustment of the assembly.

9. *Lamp receptacle.*

(a) Case shall be provided with a single contact candelabra bayonet lamp receptacle designed for electric lamps having a light center length of $1\frac{1}{4}$ in. The receptacle shall be adjusted on a rigid support and sealed in position at the factory so that a $\frac{1}{64}$ in. precision based lamp will have its filament at the focal point of the lens combination. Receptacles shall be insulated from the case and lens support.

10. *Background and hood.*

(a) Background shall be provided, having 20 in. diameter and made of copper-bearing sheet steel suitably treated to resist corrosion, and shall be not less than 0.045 in. thick. Design shall be such that it can be mounted on the unit in the field without use of special tools.

(b) A hood shall be provided, made of copper-bearing sheet steel suitably treated to resist corrosion, and shall be not less than 0.0375 in. thick and not less than 10 in. long, projecting substantially at right angles to the body of the case.

(c) Hood shall extend one-half way around the lens opening and be designed to minimize the likelihood of snow or ice accumulating on the roundel.

11. *Range and spread.*

(a) Range shall be the distance at which under bright sunlight conditions, with the sun at or near the zenith, the indication will be clear and distinct to a person with normal vision.

(b) Range shall be determined when the light unit is operated with a 10-volt, 18-watt single filament lamp of 1,000 hours design life burning at 10 volts.

*Alternate requisites section.

11. *Range and spread.*—Continued.

(c) For mast mounted signals at standard height, 7 to 9 ft.:

1. When equipped with a 30 deg. horizontal spread, 15 deg. downward deflection roundel the range shall be:

	Ft.
On the axis.....	2,200
5 deg. either side of axis.....	2,100
10 deg. either side of axis.....	2,000
15 deg. either side of axis.....	1,700

2. When equipped with a 70 deg. horizontal spreadlight roundel without downward deflection, the range shall be:

	Ft.
On the axis.....	1,800
5 deg. either side of axis.....	1,600
10 deg. either side of axis.....	1,200
15 deg. either side of axis.....	1,000
20 deg. either side of axis.....	650
25 deg. either side of axis.....	525
30 deg. either side of axis.....	325
35 deg. either side of axis.....	250

(d) For cantilever mounted signals and mast mounted signals higher than 9 ft.:

1. When equipped with a 20 deg. horizontal spread, 32 deg. downward deflection roundel, the range shall be:

	Ft.
On the axis.....	1,300
5 deg. either side of axis.....	1,000
10 deg. either side of axis.....	800

2. When equipped with a diffusing roundel, the range in feet shall be:

Degrees below the axis	Degrees either side of axis					
	Axis	2	5	10	15	20
Axis	1,700	600	300			
2	1,400	600	300			
4	850	600	525			
6	750	675	675	675	600	525
8	650	625	625	600	550	450
10	525	450	450	450	375	
12	375	325	325	300	225	

12. *Painting.*

(a) Case shall be painted with a first coat of red lead primer or equivalent inside and out and with a finish coat of non-reflecting black on the inside and on the front exposed portion in accordance with Specification 214, Manual Part 221.

(b) Hood and background shall be painted with a first coat of red lead primer or equivalent and with a finish coat of non-reflecting black in accordance with Specification 214, Manual Part 221.

13. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070.

(b) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

14. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom, except the lamp receptacle which shall withstand for one minute an insulation test of 800 volts a.c.

(b) With the exception of the lamp receptacle, a surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

15. *Identification.*

(a) Case or door shall be plainly marked with Manufacturer's name or trade-mark.

16. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

17. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

18. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

19. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which has been subject to misuse, negligence or accident.

Alternate requisites.

R-6-c.

Case and door or doors shall be:

1. Cast aluminum alloy, in accordance with A.S.T.M. current Specification B 26, Alloys CS-22 or S-2.
2. Die cast alloy, in accordance with A.S.T.M. current Specification B 86, Alloy XXI or XXIII.

R-6-f.

Side light openings shall be blanked.

R-8-c.

Roundels shall be $8\frac{3}{8}$ in. diameter, convex, clear, and as specified by the Purchaser, with horizontal spread and downward deflection.

Action Recommended

Acceptance for submission to letter ballot.

ASSOCIATION OF AMERICAN RAILROADS
JOINT COMMITTEE ON METRIC SYSTEM

A. S. Haigh, Representative

The following article is a reprint of material published by the American Standards Association*, and gives the present status of legislation on the metric system in this country. The Joint Committee participated in the survey.

Industry Favors Legal Basis for Inch-Millimeter-Light Wave Ratio

The results of a survey to determine the attitude of American industry toward proposed legislation which would legalize the simplified ratio of 25.4 between the millimeter and the inch, and establish a relationship between the inch and a light wavelength, were announced by the Special Committee on Metric Policy to the Standards Council at the Annual Meeting of the American Standards Association.

The Standards Council, in turn, voted to forward these results to the Department of Commerce for use as information in connection with a bill which would legalize the simplified conversion factors. The Committee on Metric Policy had recommended that since the Company Members of the American Standards Association comprise a fairly representative cross section of American industry, their answers to a specific questionnaire on the subject would provide much desired information.

Approximately 2100 Company Members were asked the following three questions:

1. Would the proposed legislation for the simplified ratio of 25.4 between the millimeter and the inch be advisable at this time?
2. Would the proposed legislation establishing a ratio between the inch and a light wavelength, such as the red radiation of cadmium, be advisable at this time?
3. Will the legalization of these proposals be of benefit to your organization?

Of the total number responding to the questionnaire, the majority definitely favored this legal action.

More specifically, of the 468 questionnaires returned, the vote showed 418 affirmative replies to question 1; 360 affirmative replies to question 2; and 246 affirmative replies to question 3.

The proposed legalization of both the English and the metric systems would permit the use of either to the extent that it would be of advantage to do so, either in national or international relations. Since early colonial days, repeated efforts have been made in America to establish national standards of measurement, particularly those concerned with the customary system of weights and measures. The Constitution of the United States delegates to Congress the power to fix such standards. A standard of length, which could, if necessary, be independently reproduced from physical observations, received frequent consideration and interest from early American Congresses.

A resolution passed by the Senate in 1836 directed the Secretary of the Treasury to supply the governors of each state with a set of all weights and

* *Industrial Standardization*, Vol. 18, No. 11, November-December 1947, page 283.

measures used by the Treasury Department in the collection of customs. These included an avoirdupois pound of 7000 grains and a yard of 36 inches. No congressional action was taken to legalize these standards, but several states adopted them independently and a groundwork for uniform weights and measures was at last provided.

It was not until after the Civil War, however, that Congress took a formal step to legalize a system of weights and measures, and this did not relate to those commonly used, but to the metric system. The act of 1866 made the use of metric units lawful throughout the United States. The meter was defined as equivalent to 39.37 inches, while the millimeter was rounded off to 0.0394 inch—this, in spite of the fact that the length of the inch had never been fixed.

Thus, there has existed in this country a legalized system of metric weights and measures, used for scientific purposes, and a customary system which is in common use but has never been legalized.

Government Receives Meter Bar and Kilogram

The Government as a participant in the Metric Convention received the platinum-iridium meter bar and kilogram. These, together with the Troy pound, constitute the only legal material standards possessed by the United States. Accordingly, in 1893, the Superintendent of the Coast and Geodetic Survey issued an order to the effect that the Office of Weights and Measures would regard the international prototype meter and kilogram as fundamental standards and the customary units—the yard and the pound—would be derived therefrom in accordance with the act of July 8, 1866. Thus 1 inch equals $25.40005 \pm$ millimeters. The United States then had a theoretical inch rather than one which could be derived with exactness. Furthermore, the American inch was approximately four-millionths longer than the British inch which derived its value directly from the Imperial Yard.

25.4 Millimeters per Inch Adopted in Common Practice

In the intervening period, it has become common practice for engineering purposes, both in the United States and Great Britain, as well as in 13 other countries, to use the simpler relation 1 inch equals 25.4 millimeters exactly. This ratio falls between the present accepted values of the British and the United States inch. It was recognized as a national standard as far back as 1933 when the American Standards Association approved the American Standard Practice for Inch-Millimeter Conversion for Industrial Use, B48.1-1933. This American Standard has recently been reaffirmed, which indicates that those interests substantially concerned are agreed that this relation is representative of standard practice in industry.

To summarize the situation, the United States for 150 years has been using a customary system of weights and measures without "fixing" the standards on which the system is based. A bill was presented to the last Congress with the simple objective of putting the Government's house in order in this respect. The bill provided that the inch should be fixed in terms of the meter by means of a specified ratio. The ratio proposed for the inch was 1 inch equals 0.0254 meter.

The bill also carried a supplementary definition of the inch in terms of light waves. This was based upon the value adopted some ten years ago by the International Committee on Weights and Measures as the number of wavelengths of the red radiation of cadmium in a meter, a value which has been well supported over the years by several independent determinations. This supplementary definition, if adopted, will legalize the direct use of interference methods in the precise determination of the length of gage blocks and similar working standards.

The Navy Department, in 1945, formally indicated the desirability of this action to the Department of Commerce, as the Navy was finding more and more need for the use of the metric system in meeting the demands of foreign business and also in connection with the need for metric equivalents in certain classes of specifications and standards. Under such conditions legalized conversion ratios would be extremely helpful. The Department of Commerce, receptive to this proposal, prepared a bill including the simpler ratios and the basic unit of length. It was referred to the Director of the Bureau of the Budget, who desired an indication from American industry as to the desirability of the action. The questionnaire, the results of which have just been reported to the Standards Council, was circulated by the American Standards Association in an effort to ascertain industry's viewpoint on this very important question. This information, which Company Members have so co-operatively furnished the Committee on Metric Policy, will be forwarded to the Department of Commerce in the hope that it will be helpful in arriving at the ultimate decision as to whether there shall be legislation on these basic questions of our units of measurement.

Action Recommended

Acceptance as information.

COMMITTEE VII—MATERIALS RESEARCH

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G. E. Goepfert	J. R. Smith
W. W. Hartzell	P. A. Starck
Curtis Kies	G. E. Tracey
H. L. Kilian	W. F. Zane

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Investigate and report on the various types of lubricants used in car retarders, and prepare specifications where necessary.
4. Investigate and report on rust preventives.
5. Investigate and report on frost preventives.
6. Specification for target enamel paint for the several colors necessary for railroad use, such paint to be used on levers of mechanical interlocking machines also.
7. Investigate and report on the possibilities of plastics as a substitute for other materials in signal work.
8. Investigate and report on the use of stainless steel guy and messenger strand.
9. Specification for enamel primer.
10. Specification for white lead primer.

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Specification 120-44, Manual Part 110.
Revision of Requisites for Minimizing Condensation and Frost Conditions, Manual Part 188.
Revision of Specifications for Various Types of Steel, Manual Part 154.
3. Specification for Lubricant for Use in Electro-Pneumatic Valves and Cylinders.
4. Rust Preventives.
8. Use of Stainless Steel Guy and Messenger Strand.
9. Specification 237-48.
10. Specification 238-48.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 17, 1948.

Cooperative report. American Standards Association—Dry Cells and Batteries—Project C18.

Cooperative report. American Standards Association—Electrical Insulating Materials in General—Project C59.

Explanatory

Under Assignment 3—Investigate and report on the various types of lubricants used in car retarders, and prepare specifications where necessary, the Committee found that a suitable lubricant for use in electro-pneumatic car retarder valves and cylinders is the brake cylinder lubricant already in use on many roads and covered by A.A.R. Mechanical Division Specification M-914. The same lubricant is also suitable for use in other electro-pneumatic signal apparatus.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.S.T.M.—American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

A.S.A.—American Standards Association, 70 E. 45th St., New York 17, N. Y.

N.E.M.A.—National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N. Y.

S.A.E.—Society of Automotive Engineers, 29 W. 39th St., New York 18, N. Y.

Disposition of 1947 Letter Ballot Subjects

Specification 227-47—Target Enamel—Now in Manual Part 235.

Specification 230-47—Oil for Use as Buffing Agent in Spring Switches—Now in Manual Part 236.

(Revision of A.A.R. Signal Section Specification 120-44)
A.A.R. SIGNAL SECTION SPECIFICATION 120-48.

PAINT AND PAINTING

1. *Purpose.*

(a) This specification is for the purpose of providing paint and the method of its application to signal and interlocking apparatus. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Tender.*

(a) The tender shall be for material and workmanship meeting the requirements of this specification in its entirety.

3. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

5. *General.*

(a) Materials prescribed for application to apparatus as covered in this specification shall be in accordance with the following:

1. Primer paints.

(a) Primer Paint for Steel and Iron Structures—Specification 201, Manual Part 65.

(b) Primer Paint for Wood Structures—Specification 238, Manual Part

(c) Enamel Primer Paint for Steel and Iron Structures—Specification 237, Manual Part

2. Finishing paints and enamels.

(a) Aluminum Paint Suitable for Finishing Coats on Steel and Iron Structures—Specification 200, Manual Part 62.

(b) Non-Reflecting Black Coating Material for Backgrounds of Signals Employing Lights—Specification 214, Manual Part 221.

(c) Target Enamel—Specification 227, Manual Part 235.

(d) Cable Paint—Volatile Thinner—Paint and Painting of Braid-Covered Aerial Wires and Cables—Specification 181, Manual Part 151.

5. *General.*—Continued.

- (e) Cable Paint—Asphalt or Coal Tar Emulsion—
Paint and Painting of Braid-Covered Aerial Wires and
Cables—Specification 187, Manual Part 152.

6. *Mixing and thinning.*(a) *Mixing.*

1. Before using ready-to-use paint, special attention shall be given to insure thorough mixing. When the short-cut method of stirring in the original container is attempted, the pigment is merely stirred around in the bottom of the container while the liquid remains on top, resulting in the paint being poorly mixed, which leads to an inferior paint coating. To insure thorough mixing, the following procedure should be followed:

- (a) After removing lid from the container, pour off a portion of the liquid into another container.
(b) Stir the pasty mass in the bottom of the original container, then add all the liquid which was poured off, stirring constantly.
(c) Pour the paint from one container to another several times to insure a homogeneous mixture.

(b) *Thinning.*

1. For the thinning of primers, paints and enamels, for application by brushing, spraying or dipping, Manufacturer's directions shall be followed, and the specified thinners used.

7. *Cleaning.*

- (a) Surfaces shall be thoroughly cleaned. All loose or detachable mill scale, paint, rust, grease, dirt or other foreign substances shall be removed and surfaces shall be thoroughly dried before painting.

8. *Application.*

- (a) Coating materials may be applied by brushing, dipping or spraying and may be air dried or baked.
(b) Material shall be well mixed, uniformly applied with special attention given to providing adequate protection at joints and crevices, and each coat shall be dry before application of succeeding coats.
(c) Materials shall not be applied to surfaces when ambient temperature is below 45 deg. F.
(d) Surfaces that will be inaccessible after assembly or after erection shall be given a priming coat and where practicable specified finishing coats of material before assembly and erection.
(e) Surfaces that will be inaccessible after installation and which may be subjected to extreme moisture conditions shall be given an additional coating of rust-preventive material as specified by the Purchaser.
(f) Before shipment from point of manufacture, all parts and equipment requiring paint shall be given the primer coat and, when specified by Purchaser, the finished coats in accordance with Section 9.

9. *Prescribed paint coatings.*

(a) Sheet metal housings, instrument shelters, battery cases, boxes, bungalows and other sheet metal structures for outdoor installation shall be painted as follows:

1. Exterior surfaces shall be given one coat of primer, Specification 201, Manual Part 65, followed by two coats of aluminum paint, Specification 200, Manual Part 62. *R-9-a-1.

2. Interior surfaces shall be given one coat of primer, Specification 201, Manual Part 65, followed by two coats of paint of Contractor's standard color. *R-9-a-2.

(b) Sheet metal cabinets, tower cases, chaseways, interlocking and control machine cabinets and cases for indoor installation shall be painted as follows:

1. Exterior surfaces shall be given one coat of enamel primer, Specification 237, Manual Part, followed by two coats of enamel, Specification 227, Manual Part 235. *R-9-b-1.

2. Interior surfaces shall be given one coat of enamel primer, Specification 237, Manual Part, followed by one coat of enamel, Specification 227, Manual Part 235, of Contractor's standard color. *R-9-b-2.

(c) Interlocking machine parts (except levers and machine-finished surfaces) shall be given one coat of enamel primer, Specification 237, Manual Part, followed by one coat of enamel, Specification 227, Manual Part 235. *R-9-c.

(d) Levers for interlocking machines (except machine-finished surfaces and latch handles) shall be given two coats of enamel, Specification 227, Manual Part 235, colors to be as specified by Purchaser. *R-9-d.

(e) Metal hoods and backgrounds of signals employing lights shall be given one coat of primer, Specification 201, Manual Part 65, followed by one coat of non-reflecting black paint, Specification 214, Manual Part 221. *R-9-e.

(f) Sheet metal targets, signal blades, signs, etc., shall be given one coat of enamel primer, Specification 237, Manual Part, followed by one coat of enamel, Specification 227, Manual Part 235, colors to be as specified by Purchaser. *R-9-f.

(g) Structural steel and iron parts, such as signal ladders, masts, bridges, brackets, platforms, etc., shall be given one coat of primer, Specification 201, Manual Part 65, followed by two coats of paint, as specified by Purchaser. *R-9-g.

(h) Steel pipe for signal poles and cable posts shall be painted as follows:

1. Interior surface of pipe shall be given one coat of primer, Specification 201, Manual Part 65. *R-9-h-1.

* Alternate requisites section.

9. *Prescribed paint coatings.*—Continued.

2. Exterior surface of pipe shall be given one coat of primer, Specification 201, Manual Part 65, followed by two coats of paint, as specified by Purchaser. *R-9-h-2.

(i) Iron and steel castings such as car retarder parts, switch machine, circuit controller and switch lock cases; signal mechanism and relay cases; housings and cases for train control equipment, motor frames and housings, switch stands, pole bases (except machine-finished surfaces), etc., shall be painted as follows:

1. Exterior surfaces shall be given one coat of primer, Specification 201, Manual Part 65, followed by two coats of paint, as specified by Purchaser. *R-9-i-1.

2. Interior surfaces shall be given one coat of primer, Specification 201, Manual Part 65, followed by one coat of paint, of Contractor's standard color. *R-9-i-2.

(j) Forgings, bars, rods, bolts, such as car retarder and switch machine parts, etc. (except machine-finished surfaces) shall be given one coat of primer, Specification 201, Manual Part 65, followed by one coat of paint, as specified by Purchaser. *R-9-j.

(k) Wood housings for outdoor installation shall be painted as follows:

1. Exterior surfaces shall be given one coat of primer paint, Specification 238, Manual Part, followed by two coats of paint, as specified by Purchaser. *R-9-k-1.

2. Interior surfaces shall be given one coat of primer paint, Specification 238, Manual Part, followed by one coat of suitable enamel, of Contractor's standard color. *R-9-k-2.

(l) Wood arms for highway grade crossing gates shall be given one coat of primer paint, Specification 238, Manual Part, followed by two coats of paint, colors and striping to conform to Drawing 1491. *R-9-l.

(m) Braid-covered aerial wires and cables exposed to open weather conditions shall, at time of installation, be given two coats of cable paint, Specification 187, Manual Part 152. *R-9-m.

10. *Removable protective coating.*

(a) Before shipment or exposure to dampness, machine-finished surfaces shall be coated with a white lead and tallow compound, or an equivalent which shall have sufficient body to resist weather and rusting. Coating materials shall be non-injurious to metal parts and such as to permit ready removal by wiping, stripping or use of a non-injurious solvent.

11. *Inspection.*

(a) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

* Alternate requisites section.

11. *Inspection.*—Continued.

(b) If completed product has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Contractor shall pay all freight charges.

(c) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

12. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any material which has been subject to misuse, negligence or accident.

Alternate requisites.

R-9-a-1.

Exterior surfaces shall be given coats of primer, followed by coats of paint, color to be

R-9-a-2.

Interior surfaces shall be given coats of primer, followed by coats of paint, color to be

R-9-b-1.

Exterior surfaces shall be given coats of primer, followed by coats of, color to be

R-9-b-2.

Interior surfaces shall be given coats of primer, followed by coats of, color to be

R-9-c.

Interlocking and control machine parts shall be given coats of primer, and coats of, color to be

R-9-d.

Levers for interlocking and control machines shall have the surfaces above the latch shoes painted with coats of

Alternate requisites.—Continued.

enamel, Specification 227, Manual Part 235, colors to be as specified below:

	Name of lever	Color
1.		
2.		

R-9-e.

Metal hoods and backgrounds of signals employing lights shall be given coats of primer, followed by coats of non-reflecting black paint, Specification 214, Manual Part 221.

R-9-f.

Sheet metal targets, signal blades, signs, etc., shall be given coats of primer, followed by coats of enamel, Specification 227, Manual Part 235, colors to be as specified below:

	Description	Color
1.		
2.		

R-9-g.

Structural steel and iron parts shall be given coats of primer, followed by coats of paint, color to be

R-9-h-1.

Interior surface of pipe shall be given coats of primer.

R-9-h-2.

Exterior surface of pipe shall be given coats of primer, followed by coats of paint, color to be

R-9-i-1.

Exterior surfaces shall be given coats of primer, followed by coats of paint, color to be

R-9-i-2.

Interior surfaces shall be given coats of primer, followed by coats of paint, color to be

R-9-j.

Forgings, bars, rods, bolts, etc., shall be given coats of primer, followed by coats of paint, color to be

Alternate requisites.—Continued.

R-9-k-1.

Exterior surfaces shall be given coats of
primer, followed by coats of paint, color to
be

R-9-k-2.

Interior surfaces shall be given coats of
primer and coats of, color to be

R-9-l.

Wood arms for highway grade crossing gates shall be given
..... coats of primer, followed by coats
of, color to be

R-9-m.

Braid-covered aerial wires and cables exposed to open weather
conditions shall, at time of installation, be given two coats of
cable paint, Specification 181, Manual Part 151.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter
in the Manual.

Subject-matter to be Superseded

Specification 120-44—Paint and Painting, Manual Part 110.

A.A.R. SIGNAL SECTION SPECIFICATION 237-48.

ENAMEL PRIMER PAINT FOR STEEL
AND IRON STRUCTURES1. *Purpose.*

(a) This specification is for the purpose of providing enamel primer paint for steel and iron structures. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Tender.*

(a) The tender shall be for material and workmanship meeting the requirements of this specification in its entirety.

3. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

5. *General.*

(a) The Manufacturer is given latitude in the selection of raw materials and processes of manufacture provided the material meets the requirements of this specification in its entirety.

(b) The material shall be suitable for application by brushing or spraying.

(c) The material shall be of such character that it may be either air-dried or baked.

6. *Requirements.*(a) *Color.*

1. The color shall be as specified and shall be non-bleeding.

(b) *Consistency.*

1. The material shall be of brushing consistency in the packaged condition and shall be such that when thinned in accordance with the recommendation of the Manufacturer of the material, it shall be suitable for spraying. *R-6-b-1.

(c) *Stability.*

1. When material is thinned in accordance with the instructions of the Manufacturer of the material and allowed to stand in a well stoppered glass bottle for at least one hour at a temperature of 77 deg. F., the thinner shall not cause the precipitation or separation of any ingredient of the

* Alternate requisites section.

6. *Requirements.*—Continued.

material or affect the quality of the primer coating. (Slight settling of pigment is not considered objectionable.)

(d) Packaging properties.

1. The material shall show no objectionable settling or skinning in a freshly opened full can of age not exceeding 6 months, and shall be easily mixed to a homogeneous state with a paddle.

2. After standing 30 days at room temperature, a half-filled, tightly closed 1 quart container of the material shall show no livering, curdling, or lumps and shall show no more settling than can be easily and readily broken up with a paddle and redispersed. Skinning, if present, shall be of the firm, continuous variety, easily removable.

(e) Gloss.

1. When applied at film thickness of $\frac{1}{2}$ to $\frac{3}{4}$ mils on test panels prepared in accordance with A.S.T.M. current Specification D 609, the film shall have sufficiently low gloss to provide adequate adhesion for succeeding coats.

(f) Drying.

1. Material when air-dried on test panels prepared as in section 6-e-1, shall dry sufficiently for a succeeding coat in not more than 12 hours. All drying shall be conducted in a well ventilated chamber free from drafts and dust, but not in the direct rays of the sun, maintained at temperatures between 70 and 80 deg. F., and with relative humidity of 40 to 60 per cent.

2. Material when baked on test panels prepared as in section 6-e-1, shall dry hard in not more than 2 hours at 225 deg. F. All baking tests shall be run in a well ventilated laboratory baking oven capable of maintaining the specified temperature within a range of plus or minus 3 deg. F.

(g) Appearance.

1. Coated panels after drying shall present a smooth, uniform appearance, reasonably free of floating, streaking, differences in gloss and application defects such as orange peel, etc. No roughness such as unground pigment or skin particles shall be detectable by visual inspection.

(h) Hiding power.

1. Complete visual hiding power shall be obtained when applied over black and white contrasting stripes to a dry film thickness of not exceeding $1\frac{1}{2}$ mils.

(i) Adhesion and flexibility.

1. Adhesion and flexibility shall be checked on a film of the material applied on test panels prepared as in section 6-e-1, air-dried 12 hours followed by baking for 48 hours at 150 deg. F. The material shall adhere tightly and, when the film is scratched with a sharp-edged knife held at an approximate angle of 30 deg. with the panel, shall show bevelled edges and flakes shall not form or fly.

6. Requirements.—Continued.

(j) Corrosion resistance.

1. Test panels prepared as in section 6-e-1, when subjected for 200 hours to a salt spray test per A.S.T.M. current Specification B 117, shall not show more than $\frac{1}{8}$ in. creepage from scratch marks.

7. Application.

(a) Application of enamel primer paint shall be in accordance with Specification 120, Manual Part 110.

8. Inspection.

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Contractor shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

9. Tests.

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Contractor shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

10. Packing.

(a) Material shall be available in 1 quart containers and shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

11. Marking.

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment.

12. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within three months after shipment to the Purchaser. This warranty shall not apply to any material which has been subject to misuse, negligence or accident.

Alternate requisites.

R-6-b-1.

The material shall be furnished of consistency.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 238-48.

PRIMER PAINT FOR WOOD STRUCTURES

1. *Purpose.*

(a) This specification is for the purpose of providing primer paint for wood structures. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Tender.*

(a) The tender shall be for material and workmanship meeting the requirements of this specification in its entirety.

3. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

(b) Material shall be of the best commercial grade and shall be in accordance with current specifications as follows:

1. Basic carbonate (white lead)—A.S.T.M. D 81.
2. Titanium dioxide—A.S.T.M. D 476.
3. Lead zinc oxide—A.S.T.M. D 80.
4. Raw linseed oil—A.S.T.M. D 234.
5. Bodied linseed oil—U.S.N. 52-0-20.
6. Varnish—Federal TT-V-121.

5. *Composition. (*R-5.)*

Per cent by weight

(a) *Primer.*

- | | |
|-----------------|------------|
| 1. Pigment..... | 58 minimum |
| 2. Vehicle..... | 42 maximum |

(b) *Pigment.*

- | | |
|--------------------------------------|------------|
| 1. Basic carbonate (white lead)..... | 40 minimum |
| 2. Titanium dioxide..... | 13 minimum |
| 3. 35 per cent lead zinc oxide..... | 16 maximum |
| 4. Inerts..... | 42 maximum |

(c) *Vehicle.*

- | | |
|--|------------|
| 1. Totals of raw and bodied linseed oil
and varnish solids..... | 51 minimum |
|--|------------|

Note: Varnish solids not to exceed
20 per cent of the total vehicle.

* Alternate requisites section.

5. *Composition.*—Continued.

2. Thinner and drier.....	Per cent by weight 49 maximum
---------------------------	----------------------------------

Note: The thinner shall consist of petroleum hydrocarbons or turpentine. The drier shall be such as to give the specified drying properties with a maximum degree of can stability.

6. *Requirements.*

(a) Color.

1. The color shall be white conforming to the pigments specified.

(b) Consistency.

1. The material shall be of brushing consistency in the packaged condition and shall be such that when thinned according to the recommendations of the Manufacturer of the material, it shall be suitable for use by spraying.

(c) Stability.

1. When material is thinned in accordance with the instructions of the Manufacturer of the material and allowed to stand in a well stoppered glass bottle for at least one hour at a temperature of 77 deg. F., the thinner shall not cause the precipitation or separation of any ingredient of the material or affect the quality of the primer coating. (Slight settling of pigment is not considered objectionable.)

(d) Packaging properties.

1. The material shall show no objectionable settling or skinning in a freshly opened full can of age not exceeding 6 months, and shall be easily mixed to a homogeneous state with a paddle.
2. After standing 30 days at room temperature, a half-filled, tightly closed 1 quart container of the material shall show no living, curdling, or lumps and shall show no more settling than can be easily and readily broken up with a paddle and redispersed. Skinning, if present, shall be of the firm, continuous variety, easily removable.

(e) Gloss.

1. When applied at film thickness of 1 mil. to wood test panels prepared in accordance with A.S.T.M. current Specification D 358, the film shall have sufficiently low gloss to provide adequate adhesion for succeeding coats.

(f) Drying.

1. Material when applied on test panels prepared as in section 6-e-1 shall dry sufficiently for a succeeding coat in not more than 24 hours. All drying shall be conducted in a well ventilated chamber free from drafts and dust, but not in the direct rays of the sun, maintained at temperatures between 70 and 80 deg. F., and with relative humidity of 40 to 60 per cent.

6. *Requirements.*—Continued.

(g) Appearance.

1. Coated panels after drying shall present a smooth, uniform appearance, reasonably free of floating, streaking, differences in gloss and application defects such as orange peel, etc. No roughness such as unground pigment or skin particles shall be detectable by visual inspection.

(h) Adhesion and flexibility.

1. When a film of the material is applied on test panels prepared as in section 6-e-1, air-dried 48 hours, the flexibility shall be such that the film when cut with a sharp knife to form an "X" shall show no loss of adhesion or peeling between the lines of the cuts.

7. *Application.*

(a) Application of primer paint shall be in accordance with Specification 120, Manual Part 110.

8. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Contractor shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

9. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Contractor shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

10. *Shipping containers.*

(a) Material shall be shipped in containers specified by Purchaser as follows:

1. Primer paint, ready mixed, in 1 and 5 gallon cans and in drums.
2. Soft paste white lead in 12½, 25 and 50 lb. pails and 100 lb. kegs.
3. Linseed oil in 1 and 5 gallon cans and 50 gallon drums.
4. Volatile thinner or drier in 1 pint, 1 quart and 1 gallon cans.

11. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

12. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

(c) Where carload shipments are made, name and address of Consignee may be omitted.

13. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing at point of production, any part or parts to replace those which shall be found defective within three months after shipment to the Purchaser. This warranty shall not apply to any material which has been subject to misuse, negligence or accident.

Alternate requisites.

R-5.

Composition:

- 100 lbs. soft paste white lead.
- 4 gallons raw or boiled linseed oil.
- 2 gallons turpentine.
- 1 pint liquid drier. (If boiled linseed oil is used drier should be omitted.)

Action Recommended

Acceptance for submission to letter ballot.

SPECIFICATION FOR LUBRICANT FOR USE IN
ELECTRO-PNEUMATIC VALVES AND CYLINDERS

1948

The recommended specification for a lubricant for use in electro-pneumatic valves and cylinders is A.A.R. Mechanical Division Specification M-914—Brake Cylinder Lubricant.

Action Recommended

Acceptance for submission to letter ballot.

(Revision of Requisites for Minimizing Condensation and Frost Conditions)
A.A.R. SIGNAL SECTION REQUISITES.

MINIMIZING CONDENSATION AND FROST CONDITIONS

1948

1. The inner case of semaphore signal mechanisms shall be constructed so as to close as near air-tight as practicable. The outer case shall be ventilated by openings near the bottom and the top of the case, the openings covered with wire gauze to exclude dirt and insects, and hooded to exclude rain.

2. Housings and non-metallic lining of metal housings shall be constructed so as to close as near air-tight as practicable. The outside housing shall be ventilated by openings near the bottom and the top of the housing covered with wire gauze to exclude dirt and insects, and hooded to exclude rain.

3. Where the signal mast or cable post is connected to the top of the case, ventilators shall be located near the top of the mast or post.

4. Careful and complete sealing of all openings in the signal apparatus case and housings shall be provided where conduit, trunking or other openings lead below the surface of the ground or into receptacles below the ground, to prevent warm, or moisture-laden, air currents from entering the case.

5. The voids between and around the wires at the point where they enter the relay housing or mechanism case shall be filled with an approved compound that will seal the opening and exclude moist air from the housing or case.

6. Eliminate depressions in the top surface of concrete foundations so that no moisture will collect. Top of foundations inside case or housing shall be covered with a suitable pitch or compound to prevent seepage of moisture through the foundation.

General.

Signal apparatus is subject, under certain weather and climatic conditions, to condensation of moisture and formation of frost which contributes to the failure of switches and signals which otherwise function satisfactorily.

To prevent or minimize failures due to condensation and frost, certain basic principles must be given consideration, as follows:

- (a) Prevent any direct leakage of moisture into housings.
- (b) Prevent any entrance of moist air from ground or underground.
- (c) Restrict or remove moisture in the air within housings.
- (d) Prevent moisture freezing on parts.

Moisture in switch and signal mechanism cannot be entirely controlled but may be minimized. Artificial heat will tend to prevent the freezing of any condensate that might form but is not always available or economical, therefore not always practical.

Information.

Investigation of current practice discloses two methods are prevalent in combating moisture and freezing in signal apparatus case and housing herein classified as the "external method" and the "internal method." Either method has been used with various degrees of success.

External Method

The external method entails coating or covering the outer housing, particularly the top, ends and sides of the mechanism case with a thermal insulating material to prevent sudden and extreme change of temperature inside the housing.

Coating the apparatus housing covers, ends and sides with an insulating material, as described above, prevents this area from cooling off faster than the bottom. Since the bottom of the apparatus housing cools first, moisture from the air inside the housing will condense on the inner side of the bottom and be retained on the bottom in the form of frost. In the morning when the sun hits the top of the housing there will be no frost on the underside of the cover to melt, and therefore no dripping of water on apparatus from the cover will occur.

These coating materials may be purchased under various trade-names and in general consist of an asphalt emulsion containing granulated cork or other insulating materials, which materially assist in the prevention of condensation drip.

It may be applied by brushing, troweling, or spraying. Some manufacturers market spraying equipment for the application of their product.

Internal Method

The internal method requires the installation of a drying agent inside the housing, or the application of a thermal insulating material.

Drying agents.

When using a drying agent the mechanism housing must be as air-tight as possible. All air vents must be removed and gaskets kept in excellent condition, as it is only by the exclusion of as much moist air as possible that the drying agent can be expected to accomplish results. The drying agent saturates in direct proportion to the amount of moisture contained in the air coming into the unit and if the mechanism housing is opened the drying agent must extract the moisture from the newly admitted air. Once the drying agent becomes saturated it must be removed and dehydrated before it can be effective for further removal of moisture from the air.

Silicon-dioxide, commonly known as "Silica-Gel," is marketed for use in switch and signal mechanism housings, and is manufactured from the reaction product of sulphuric acid and sodium silicate. It is completely inert chemically but has the physical ability to absorb about 45 per cent of its own weight in water vapor. The nature of this material permits packing in a compact perforated container which may generally be accommodated in most mechanism housings. It is marketed in two types, one white in color which does not indicate when it is saturated, the other a deep purple when dehydrated and a very light pink when completely saturated. The colored type known as "Tel-Tale Silica-Gel" has the advantage of clearly indicating when dehydration of the dryer is essential for continued functioning.

The silica-gel type dryer may be dehydrated and used repeatedly. This entails shipping, dehydration by baking, and storing in sealed shipping containers ready for further service.

Thermal insulating material.

Many different types of thermal insulating material for application as a heavy coating and with characteristics that minimize condensation or prevent the dripping of condensation have been investigated.

Caution must be used in all these applications because of the tendency to "dust-off" and contaminate contacts and bearings, and also because they are usually not fireproof.

Any type of coating for internal use that provides thermal insulation and is free from dusting-off, and is not easily inflammable, should be worthy of further consideration. Some minimizing of condensation may be expected through use of suitable thermal insulating coatings on interior surfaces.

Other methods.

"Chemically pure glycerine" in a small open container, placed inside the apparatus housing has been found to be beneficial. Container must be only partially filled with glycerine so as to provide room for absorbed moisture. Care must be exercised to remove the containers for disposal of the water before overflow of glycerine can occur.

Other chemicals, with moisture absorption characteristics, have also been used. These should be avoided if injurious effects, corrosive or otherwise, result to the apparatus.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Requisites for Minimizing Condensation and Frost Conditions,
Manual Part 188.

(Revision of Specifications for Various Types of Steel)

SPECIFICATIONS FOR VARIOUS TYPES OF STEEL

1948

The recommended specifications for various types of steel shall meet the requirements of the current specifications of the American Iron and Steel Institute as follows:

Specification C1020 or C1022 (SAE-1020 or 1022) for a general utility grade of open hearth carbon steel suitable for forged and other parts requiring no special physical properties. These steels may be case hardened. C1022 is a high manganese variant of C1020 for the purpose of improving machineability and hardening properties.

Specification C1035 (SAE-1035) for a steel suitable for forged parts, gears, shafts, rods, etc., which are to be heat-treated and shall apply in the manufacture of rods having sets of 1 inch or more and used with heavy loads, such as slip switches and movable point frogs.

Specification B1112 or B1113 (SAE-1112 or 1113 formerly 1112 or X1112) for a free machining grade of steel made by the Bessemer process. Steel supplied under the specification reference will ordinarily be "cold-rolled" unless "hot-rolled" is called for. The physical characteristics of the "cold-rolled" material are superior to the "hot-rolled," and in addition, "cold-rolled" will in many instances fill drawing requirements as to finish without further machining. Reference to these specifications, therefore, should also specify "cold-rolled."

Specification C1118 (SAE-1118 formerly X1315) for a steel used extensively for case-hardened parts and where superior machining properties are desired.

Specification 1335 (SAE-1335) for a manganese alloy steel where greater strength and toughness are required than is possible with plain carbon steel but where the conditions do not justify the higher physical properties obtained by the more expensive alloy steel 3130. Specification 1335 steel is primarily an oil hardening steel so great care should be exercised in water quenching.

Specification 3130 (SAE-3130) for a nickel chromium steel suitable for water quenched parts where greater strength and toughness are required than is possible with plain carbon steel.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specifications for Various Types of Steel,
Manual Part 154.

RUST PREVENTIVES

Supplementing report presented at the 1947 Annual Meeting* on rust preventives with their recommended use, the following products are submitted as additional information:

Masters Metallic Compound is reported as preventing destructive bonding and galling of stud threads, stops rust and corrosion, seals flanges and threaded joints, permitting easy disassembly even years later. It is claimed to be impervious to most gases, vapors and penetrating liquids, sealing connections efficiently under high pressures and temperatures.

Railway Insulmat is a product manufactured for the purpose of coating interiors of box car ceilings, walls and ends of railroad passenger cars; locomotive cabs, etc., and in addition to other advantages, protects metal against rust and corrosion. It is of plastic consistency, non-inflammable, odorless, and non-toxic. This material has been used as a coating to some extent, with success, on power switch-and-lock movements for the purpose of mitigating trouble due to the accumulation of frost inside the circuit controller due to sudden changes in temperature.

Rust-i-cide—a product claimed by the manufacturer to stop rust wherever metal is exposed to the elements that cause rust either inside or outside. May be used as a primer for new metal for painting—removes rust from chromium and verdigris from brass and copper. The product may be obtained in the consistency of paint and may be so applied.

Ucilon is a plastic based coating which is reported as having corrosion-resisting properties. The product is a plastic based coating that resists acids, alkalis, oils, water, alcohols, salts and many other destructive elements.

Valvoline-X-Rust 475-A is a product manufactured to provide high rust preventive characteristics. May be obtained in consistency for brushing or when heated to approximately 130 degrees F. may be used for spraying.

Carborustex—a rust solvent which it is claimed will remove rust completely and can be worked under all conditions. It is non-inflammable and non-toxic. It will spread evenly and rapidly leaving no globules. Contains a rust inhibitor retarding further rusting. Supplied only in a concentrated form ready to mix with water.

The Committee, in addition to investigating and reporting on products manufactured for the purpose of rust prevention, are analyzing the products now commercially available with the idea in mind of submitting recommendations regarding the use of the various products for specific purposes for inclusion in the Manual.

The trade-names used herein are for the purpose of identifying types.

Action Recommended

Acceptance as information.

* A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, pp. 242-A and 403-A.

USE OF STAINLESS STEEL GUY AND MESSENGER STRAND

It develops that six railroads have made a purchase of stainless steel guy or messenger wire $\frac{1}{4}$ inch to $\frac{3}{8}$ inch for signal and communication purposes, such as messenger for supporting cable and guy wire for guying open wire lines. The amount purchased is about 60,000 feet. The purpose of the purchase was to develop the advantages derived from the use of this type guy and messenger wire over the old, in locations where severe corrosion difficulties have been experienced with types formerly used. Two railroads report a limited amount in service; however, the length of service has been so short that a definite opinion as to its relative merits cannot be formed. One railroad reports having placed a portion of the wire on accelerated tests in their test laboratory which tests as yet have not been completed.

The manufacturers advise that a considerable quantity of the guy and the messenger wire is being used by some of the utilities with very good results. Some of the installations have been in service a number of years, in territory where bad corrosive conditions have been experienced, with little or no ill effects having been noticed on the strand.

This assignment will be continued and additional information furnished as experience is gained.

Action Recommended

Acceptance as information.

COOPERATIVE REPORT

AMERICAN STANDARDS ASSOCIATION
DRY CELLS AND BATTERIES—PROJECT C18

H. L. Kilian, Representative

The Committee formed in 1926 under the sponsorship of the National Bureau of Standards, consisting of representatives of battery manufacturers, radio and electrical technical groups, and United States Government departments, has prepared five revisions of the specifications which became American Standards in 1928, 1930, 1937, 1941 and one approved August 6, 1947 and issued December 1, 1947 as American Standard C18.

As a result of the committee work, the shelf deterioration of No. 6 size dry cells occurring in a period of 6 months has been materially reduced.

The useful output of all types of dry cells, measured by their service life on various tests shown in the specification has been materially increased.

The proportions of poorer brands on the market has decreased so that there has been considerable gain to the users.

Action Recommended

Acceptance as information.

COOPERATIVE REPORT

AMERICAN STANDARDS ASSOCIATION
ELECTRICAL INSULATING MATERIALS IN GENERAL—
PROJECT C59*E. B. Smith, Representative
W. F. Zane, Alternate

At a meeting of the Sectional Committee, November 5, 1947, the Secretary reported that the following A.S.T.M. methods had been revised in 1946 and on the recommendation of Sectional Committee C59 were submitted to the A.S.A. for reapproval as American Standard:

A.S.T.M. Methods of:

- Testing Sheet and Plate Materials Used in Electrical Insulation (D 229-43; C59.13—1944)
- Testing Laminated Tubes Used in Electrical Insulation (D 348-42; C59.14—1943)
- Testing Laminated Round Rods Used in Electrical Insulation (D 349-42; C59.15—1943)

At this meeting it was brought out that the Methods of Test for Insulation Resistance of Electrical Insulating Materials (D 257-38; C59.3—1939) were also revised at the 1946 Annual Meeting of A.S.T.M., and the recommendation that the revisions be submitted to letter ballot of the Sectional Committee was submitted to a reviewing committee consisting of Messrs. W. B. Kouwenhoven and C. R. Troop. It was the recommendation of the reviewing committee that since important revisions are pending in the methods, no action should be taken by the Sectional Committee at this time, but to wait until the further revisions are approved by the A.S.T.M. committee.

It was further reported that a letter ballot was out in Sectional Committee C59 covering the revision and reversion to tentative of the A.S.T.M. Specifications for Rubber Insulating Tape (D 119-38; C59.6—1939), which took place at the 1946 A.S.T.M. Annual Meeting, and the revisions in the Tentative Methods of Test for Impact Resistance of Plastics and Electrical Insulating Materials (D 256-43T; C59.11—1944) which were adopted in 1947. Two members of the Sectional Committee had not returned ballots, and a negative vote was cast by Mr. L. E. Kearney on submitting D 119-46T to the A.S.A. His reason for so voting was on the basis that he believed further revisions were being considered in the specifications and it would be better to withhold submitting the tentative to the A.S.A. until the further revisions were made. Discussion brought out that one of the important changes concerned the percentage of the rubber content of the tape, and it was the consensus of the committee that the tentative should not be submitted to the A.S.A. at this time. On motion by Mr. Chadbourn, seconded by Mr. Kearney, it was

Voted to withhold submitting the A.S.T.M. Specifications for Rubber Insulating Tape (D 119-46T) to the A.S.A. for approval as American Standard until the pending revisions have been made.

* Previous report on Project C59 appears in A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, p. 231.

Sept. 1948]

Committee VII—Materials Research

A special reviewing committee consisting of Messrs. Chadbourn and Evans was appointed to consider the desirability of submitting to the A.S.A. the N.E.M.A. Standard for Laminated Thermosetting Products, and N.E.M.A. Recommended Practice for Fabricating Laminated Plastics as revisions respectively of N.E.M.A. Laminated Phenolic Products Standards (C59.16—1944), and N.E.M.A. Practice for Machining and Punching of Laminated Phenolic Plate (C59.17—1944). As Chairman of the reviewing committee, Mr. Chadbourn reported that these standards had received careful consideration and it was recommended that they be submitted to letter ballot of the Sectional Committee looking toward their submission to the A.S.A. On motion by Mr. Chadbourn, seconded by Mr. Evans, it was

Voted to submit to letter ballot in the Sectional Committee the recommendation that the N.E.M.A. Standard for Laminated Thermosetting Products, and N.E.M.A. Recommended Practice for Fabricating Laminated Plastics be submitted to the A.S.A. for approval as American Standard in the form of revisions of C59.16—1944, and C59.17—1944.

Action Recommended

Acceptance as information.

COMMITTEE VIII—HIGHWAY GRADE CROSSING PROTECTION

Personnel

E. W. Reich, Chairman	
W. H. Stilwell, Vice-Chairman	
H. A. Appleby	E. N. Pearson
A. Davies	W. F. Price
R. B. Elsworth	H. C. Sampson
H. T. Fleisher	W. R. Smylie
H. C. Griffith	C. H. Tillett
S. B. Higginbottom	E. P. Weatherby
S. W. Law	L. S. Werthmuller
H. G. Morgan	H. D. Blake*
M. A. Otterbourg	H. A. Franklin*

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Report on any development on highway grade crossing protection.
4. Investigate and recommend corrective measures to minimize or eliminate phantom indications of flashing light signals, outlining conditions under which they occur and the corresponding remedy in each case, including the possible use of non-reflector type electric light units.
5. Illumination of crossings.
6. Investigate and report on the use of diffusing lenses in electric light units for highway crossing signals to provide a wider range of indication where a long view is not required.
7. Prepare typical location plans for highway grade crossing protection devices.
8. Requisites to insure equal timing of operation of automatic highway crossing protection devices, based on trains moving at uniform or predetermined speeds throughout the approach to the crossing.
9. Investigate and report on the durability and methods of maintenance of reflectorized signs.
10. Investigate and report on methods for focusing and aligning railroad highway grade crossing flashing light signals in the field.

The Committee submits for consideration, reports on the following subjects**:

1. Revision of Requisites for Highway Grade Crossing Signals, Manual Part 148.

* Consulting Member.

** Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 17, 1948.

3. Development on highway grade crossing protection.
4. Non-reflecting coatings on signal lenses.
6. Use of diffusing lenses in flashing light signal units to provide a wider range of indication where a long view is not required.
7. Typical location plans for highway grade crossing protection devices.
8. Requisites for Equal Timing of Operation of Automatic Highway Grade Crossing Protection Devices.
9. Durability and maintenance of reflectorized signs.

Disposition of 1947 Letter Ballot Subjects

Requisites for Automatic Gates—Highway Crossings at Grade Over Railroad Tracks—Now in Manual Part 35.
Specification 231-47—"No Right Turn"—"No Left Turn" Illuminated Sign—Now in Manual Part 237.

DEVELOPMENT ON HIGHWAY GRADE CROSSING PROTECTION*

Highway grade crossing roadway layout.

The construction of deceleration lanes to the right and the outside of the normal traffic lanes is provided in a recently engineered highway crossing with a railroad at grade.

The highway plan is for dual lane construction with two lanes of traffic in opposite direction on either side of a 4-foot parkway.

The statutory requirement that busses, oil trucks, etc., stop before passing over a grade crossing and the hazards incidental thereto, created by the impatience on the part of following vehicles, which may not be required to stop by law, indicated the desirability of the additional facilities.

The highway has been widened to six-lane in each approach to the crossing and over the crossing for some distance beyond. The additional lane to the right and the outside of each traffic stream permits traffic, that is required by law to stop at the grade crossing, to decelerate, stop, accelerate and again merge with the normal flow of highway traffic with a minimum of delay and interference to other vehicles.

Action Recommended

Acceptance as information.

* Previous report on this subject appears in A.A.R. Signal Section 1938 Proceedings, Vol. XXXVI, pp. 196 and 301.

DURABILITY AND MAINTENANCE OF REFLECTORIZED SIGNS

Investigation has been made by questionnaire issued to Voting Representatives of Member Roads in the Signal Section.

All replies are based on maintenance of signs with reflector units in accordance with A.A.R. Signal Section drawings and are summarized as follows:

Replies received from 19 roads indicated they have no reflectORIZED signs in service.

Several roads reported reflectORIZED signs in service 15 to 16 years with signs still in good condition. No conclusive results could be developed from the replies as to the effect of location, climate or method of cleaning on the service life of the reflectORIZED signs. Vitreous enameled signs were generally preferred to those made with synthetic baked enamels.

Analysis of replies received from 41 roads using these signs shows that 61 per cent wipe with a dry cloth, 17 per cent wash with soap and water and 22 per cent use commercial cleaners for cleaning the signs "in place." Most roads stated that the reflectORIZED signs were painted and reflectORIZED buttons replaced as required, the signs usually being removed to a shop or maintainers headquarters for rehabilitation.

Action Recommended

Acceptance as information.

(Revision of Requisites for Highway Grade Crossing Signals)
A.A.R. SIGNAL SECTION REQUISITES.

HIGHWAY GRADE CROSSING SIGNALS

1948

1. *Purpose.*

(a) The purpose of these requisites for highway grade crossing signals is to set forth the general requirements representing modern practices recommended for new installations and the replacement of existing installations when general renewal or replacement becomes desirable.

2. *Aspect.*

(a) A signal used for the protection of traffic at a railroad highway grade crossing shall present an aspect toward approaching highway traffic conforming to Drawing 1651, 1652, 1653, 1654, 1686 or 1688. The operative part of the signal, when indicating the approach of a train, shall present the appearance of a horizontally swinging red light or swinging disc.

3. *Mounting.*

(a) Either flashing light type or wig-wag type signals may be used, but both should not be used at the same crossing.

(b) One signal shall be placed on each side of the track preferably to the right of approaching highway traffic.

4. *Painting.*

(a) Discs and signs shall be painted to conform to Drawings 1553, 1640, 1643, 1644, 1645, 1646, 1648 and 1650.

(b) Parts which function as background for light signal indications shall be painted with non-reflecting black in accordance with Specification 214, Manual Part 221.

(c) All other parts shall be painted white or aluminum.

5. *Operating time.*

(a) Signals indicating the approach of a train shall operate for such period of time before the arrival of any train operated over the crossing as is reasonably required to protect highway traffic.

(b) Where the distance from the most remote signal to the clearance of the farthest track, as measured parallel to the center line of the highway, is 35 ft. or less, the signals shall operate for not less than 20 seconds before the arrival of any train on a main track. Where this distance is more than 35 ft., the minimum time should be increased by one second for each additional 5 ft.

(c) For trains in either direction on main tracks over which trains normally operate in either direction and for trains moving with the current of traffic on main tracks over which trains normally operate in one direction only, signals shall operate until the rear of the train clears the crossing.

6. *Bell.*

(a) Bell, where required by public authority or special conditions, shall be in accordance with Specification 44, Manual Part 21.

1. Bell, when used, should be mounted preferably on the top of the mast supporting the crossing signal, with the face of the gong parallel to the highway.

2. Design of the bell mechanism shall, as far as practicable, be such as to insure proper operation during unfavorable weather conditions.

3. Size and range of bell shall be determined by local conditions.

Flashing Light Type

7. *Lamp units.*

(a) Lamp units shall be in accordance with Specification 190, Manual Part 166, and shall be arranged to shine in both directions along the highway. They shall be mounted horizontally 2 ft. 6 in. centers and preferably not less than 7 ft. nor more than 9 ft. above the surface of the highway.

8. *Range and spread.*

(a) Range shall be the distance at which the indications will be clear and distinct to a person with normal vision.

(b) Each lamp unit, when equipped with a roundel designed for 30 deg. horizontal spread, shall provide an indication having a beam candlepower of uniform intensity at any angle up to 10 deg. on either side of the axis and the range at any point within the 20 deg. angle under bright sunlight conditions, with the sun at or near the zenith, shall be not less than 1,500 ft. when a 10-watt lamp rated at 1,000 hours is burned at rated voltage.

(c) Lamp units shall display a satisfactory close indication.

9. *Flashes.*

(a) Lights shall flash alternately. The number of flashes of each light per minute shall be 30 minimum, 45 maximum. Lights shall each burn approximately the same length of time. Total burning time of both lamps shall be practically the entire operating time.

Wig-Wag Type

10. *Lights.*

(a) Signal lights shall shine in both directions along the highway.

11. *Lenses or roundels.*

(a) Lenses or roundels shall be 5 in. diameter minimum and in accordance with Specification 69, Manual Part 136.

12. *Range and spread.*

(a) The signal light, when the disc is suspended vertically, shall have a range, at night, of 1,500 ft. through a total angle of not less than 20 deg. when a 10-watt lamp rated at 1,000 hours is burned at rated voltage.

13. *Cycles.*

(a) Movement from one extreme to the other and back constitutes a cycle. The number of cycles per minute shall be 30 minimum, 45 maximum.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Requisites for Highway Grade Crossing Signals, Manual Part 148.

NON-REFLECTING COATINGS ON SIGNAL LENSES

The attention of the Committee was directed to the process developed during the war to apply a chemical coating, such as magnesium fluoride, to glass surfaces to minimize the amount of light reflected from such surfaces by external sources.

Investigation has been made to determine whether there is anything of value in this process toward reducing the possibilities of phantom in flashing light signal units due to sunlight.

The conclusions reached are that the process has no practical value for railway signal equipment exposed to sunlight conditions, for the following reasons:

1. Correction is only made for reducing surface reflection from 4 per cent to 1 per cent.
2. The correction applies only to normal incidence of light rays, and thus limits the effectiveness where convex glass surfaces are used.
3. The low percentage correction is an insignificant factor where intensities involved with sunlight are experienced.
4. The life of the coating is questionable under exposure to weather conditions.

Action Recommended

Acceptance as information.

USE OF DIFFUSING LENSES IN FLASHING LIGHT SIGNAL
UNITS TO PROVIDE A WIDER RANGE OF INDICATION
WHERE A LONG VIEW IS NOT REQUIRED

Lenses providing various degrees of spread are available for application to highway grade crossing flashing signal lamp units. The lens commonly used is 30 degree spreadlight which provides a 15 degree spread on either side of the axis of beam and 15 degree downward deflection; however, lenses of greater spread are available for use at locations where it is necessary to cover curve or

curves in the highway approach. The 15 degree downward deflection is desirable in the 30 degree spreadlight lens to provide good indication throughout the light pattern when signal is focused for a range of 1,500 feet.

Manufacturers have made available curves which indicate horizontal range and spread (light pattern) which result in prescribed type of cover glass or lenses used and when signal is equipped with recommended type of lamp burned at full voltage. Consideration should be given to the related light pattern of the type cover glass or lenses to be applied where a wider spread may be required for proper coverage of curved highway approaches to crossings protected with flashing light signals.

A practical use for a wide spread lens on flashing light signal lamp unit is to provide full coverage by back lights. The primary purpose of providing back lights is to meet the provision that lamps shall shine in both directions on the highway, more particularly to protect the driver of a vehicle located other than in the lead of a line of traffic approaching from the side opposite the back light and to provide an indication when a vehicle approaching close to crossing is no longer within full lens coverage of front lights, which condition occurs in a varying degree depending on focus of front lights. In order to obtain full measure of protection it follows while the range of the back light may be somewhat less than that of the front light, the spread should be such as to cover practically the entire highway at a point adjacent to and in the immediate vicinity of the signal on the opposite approach.

Figure 1 indicates an installation typical of the crossing in built-up residential area with a nominal 3-foot curve and gutter section between center of mast and edge of improved highway. The horizontal focus of both front and back lights intersects center of highway approach 1,500 feet from the crossing. The figure comprehends 30 degree spreadlight lens applied to the front light and 70 degree to the back lights.

The figure indicates the coverage on a typical two track crossing with signals placed 15 feet from center of near track and with track centers of 13 feet. Center or axis of beam of both front and back lights should be varied depending upon local conditions, noting that whereas the figure shows coverage with typical crossing of two tracks, this coverage will vary with single or three or more track crossings and with highways of varied width, location and height of signal. The purpose of the drawing is to indicate the advantages to be gained by the use of a wider spread lens and shorter range back light than in the units used as front lights.

To provide improved coverage of highway approaches where signals are mounted on cantilever structures, a greater degree of downward deflection of light from front and back lights is required.

Figure 2 indicates in profile the vertical coverage obtained in using cover glass or lenses designed for additional downward deflection. It indicates the advantages of using a somewhat shorter range but with greater degree of downward deflection cover glass for the back lights. The figure, which is typical, indicates the vertical coverage with front lights focused to a point 1,500 feet and the back lights to a point 750 feet removed from the crossing.

Action Recommended

Acceptance as information.

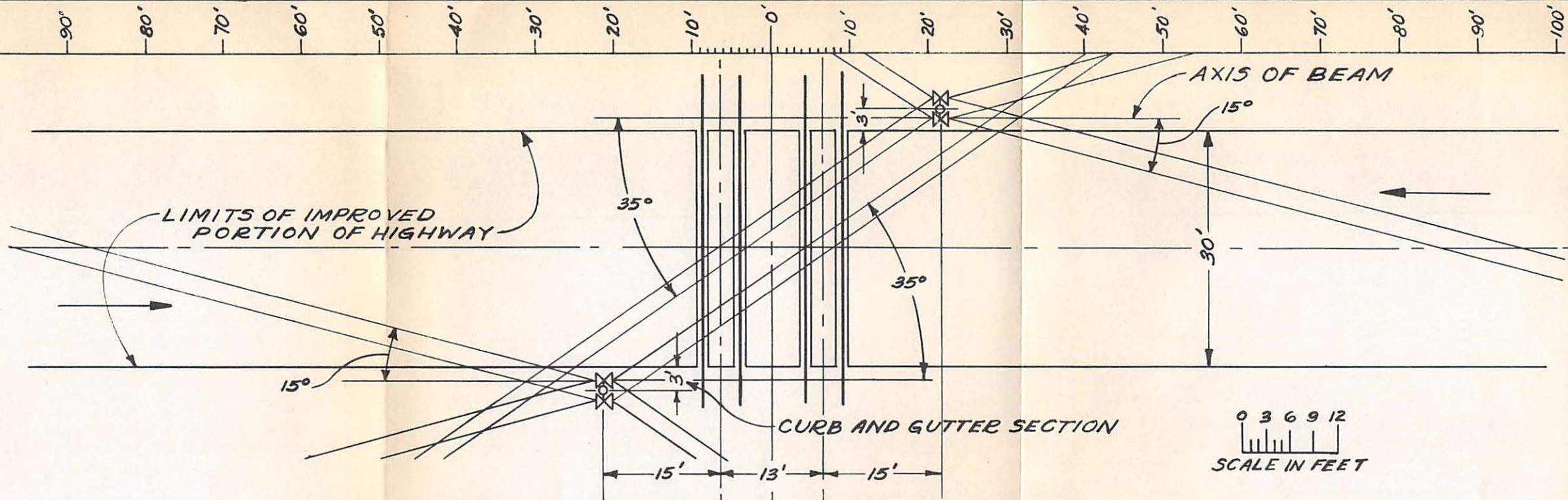


FIGURE 1 - SIGNALS ON STRAIGHT MAST

AREA OF HIGHWAY COVERED BY HORIZONTAL LIGHT BEAM FROM SIGNALS HAVING FRONT LIGHTS EQUIPPED WITH 30° SPREADLIGHT LENS AND BACK LIGHTS WITH 70° SPREADLIGHT LENS. AXIS OF BEAM INTERSECTING CENTER OF HIGHWAY APPROACH 1500' FROM CROSSING.

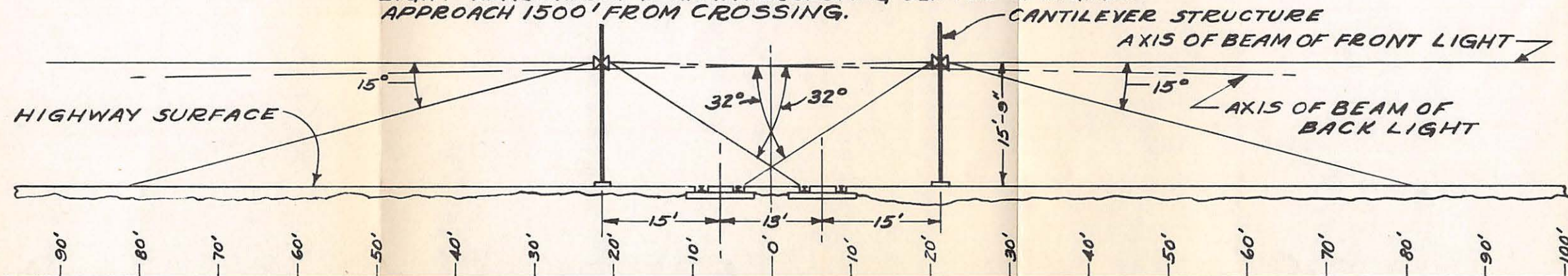


FIGURE 2 - SIGNALS ON CANTILEVER STRUCTURE

AREA OF HIGHWAY COVERED BY DOWNWARD DEFLECTED LIGHT BEAM FROM SIGNALS HAVING FRONT LIGHTS EQUIPPED WITH 15° DOWNWARD DEFLECTING LENS, WITH AXIS OF BEAM INTERSECTING CENTER OF HIGHWAY APPROACH 1500' FROM CROSSING; AND BACK LIGHTS WITH 32° DOWNWARD DEFLECTING LENS, WITH AXIS OF BEAM INTERSECTING CENTER OF HIGHWAY APPROACH 750' FROM CROSSING.

ON HIGHWAY CROSSING SIGNALS BEAM SPREAD OF DEFLECTING LENSES

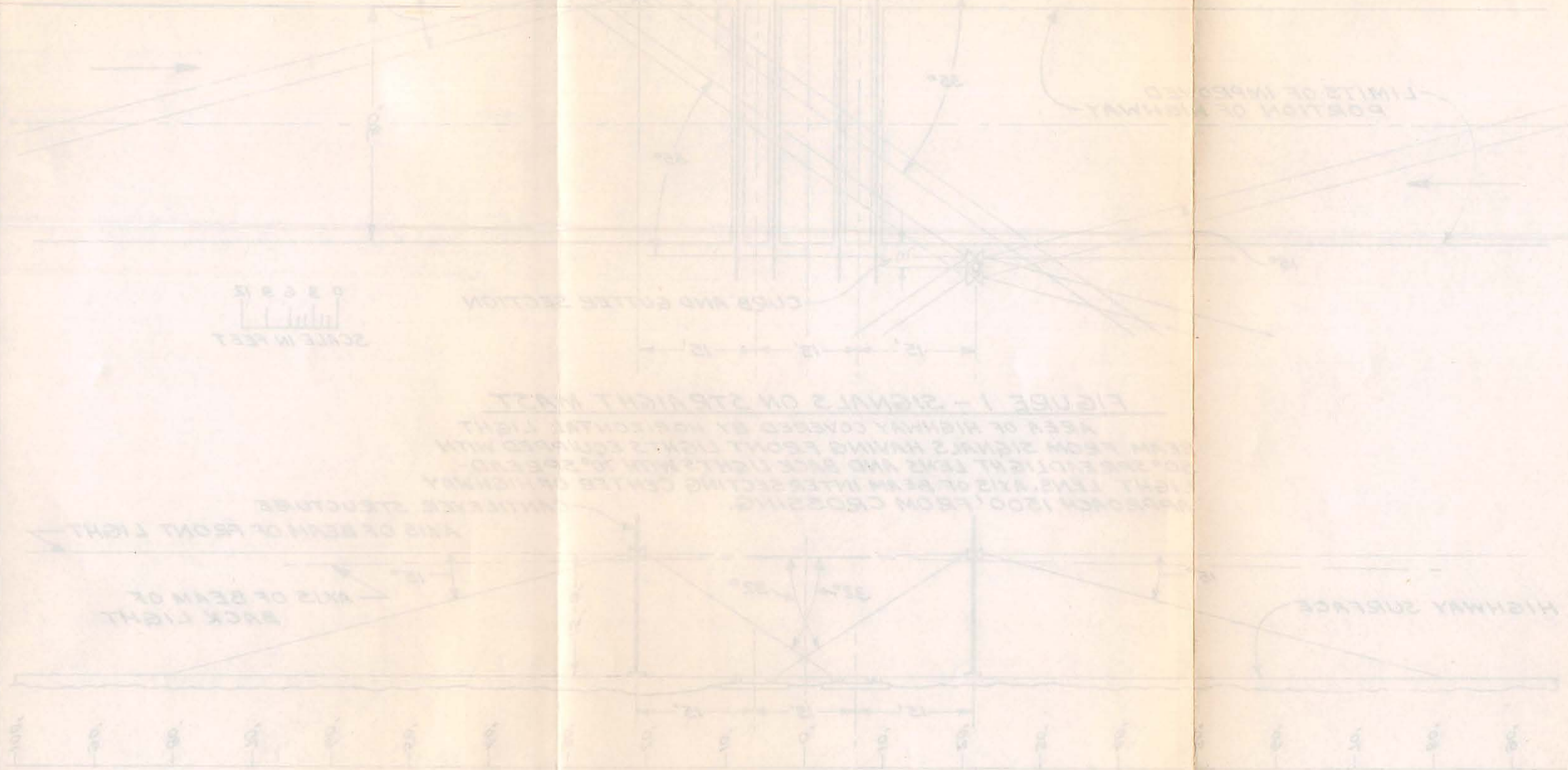


FIGURE 1 - SIGNALS ON STRAIGHT MAST
 AREA OF HIGHWAY COVERED BY DEFLECTED LIGHT BEAM FROM SIGNALS HAVING FRONT LENS DEFLECTING LENS WITH 15° DOWNWARD APPROACH 150' FROM CROSSING, AND BACK LIGHTS WITH 15° DOWNWARD APPROACH 150' FROM CROSSING.

FIGURE 2 - SIGNALS ON CANTILEVER STRUCTURE
 AREA OF HIGHWAY COVERED BY DEFLECTED LIGHT BEAM FROM SIGNALS HAVING FRONT LENS DEFLECTING LENS WITH 15° DOWNWARD APPROACH 150' FROM CROSSING, AND BACK LIGHTS WITH 15° DOWNWARD APPROACH 150' FROM CROSSING.

TYPICAL LOCATION PLANS FOR HIGHWAY GRADE
CROSSING PROTECTION DEVICES

Whereas the location of flashing light signals in general presents no problem in the protection of right angle crossings, particular consideration should be given to the location of signals where the highway intersects railroad at other than a right angle so as to provide essential protection with minimum distance between signals and with due regard to railroad clearance.

Figure 1 shows signals located approximately 15 feet from the center of track and with center of mast 6 feet from the edge of traveled roadway, both dimensions may be varied in the field to meet local conditions.

Figures 2 and 3 show location of signals for the protection of oblique angle crossings.

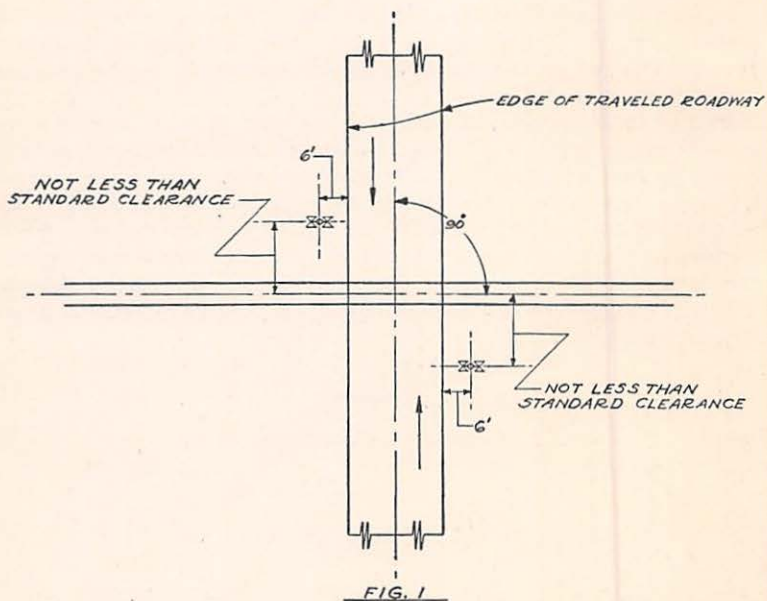
Figure 2 with center of mast 6 feet from edge of traveled roadway is similar in that respect to the right angle crossing; however, in this case the location of the mast with respect to the crossing proper is determined by the minimum requirements of railroad clearance.

Figure 3 shows signals located with highway intersecting the railroad in the opposite angle. In this case the signals are again shown located with center of mast 6 feet from the edge of traveled roadway; however, with respect to crossing proper the location of signal is fixed by first determining point where line parallel to and located 10 feet from center of track intersects the center line of highway and from the point of intersection to project a line perpendicular to the center line of highway to a point 6 feet outside the outer edge of highway.

In both Figures 2 and 3, it should be noted that the distance between signals is determined by the angle of crossing intersection.

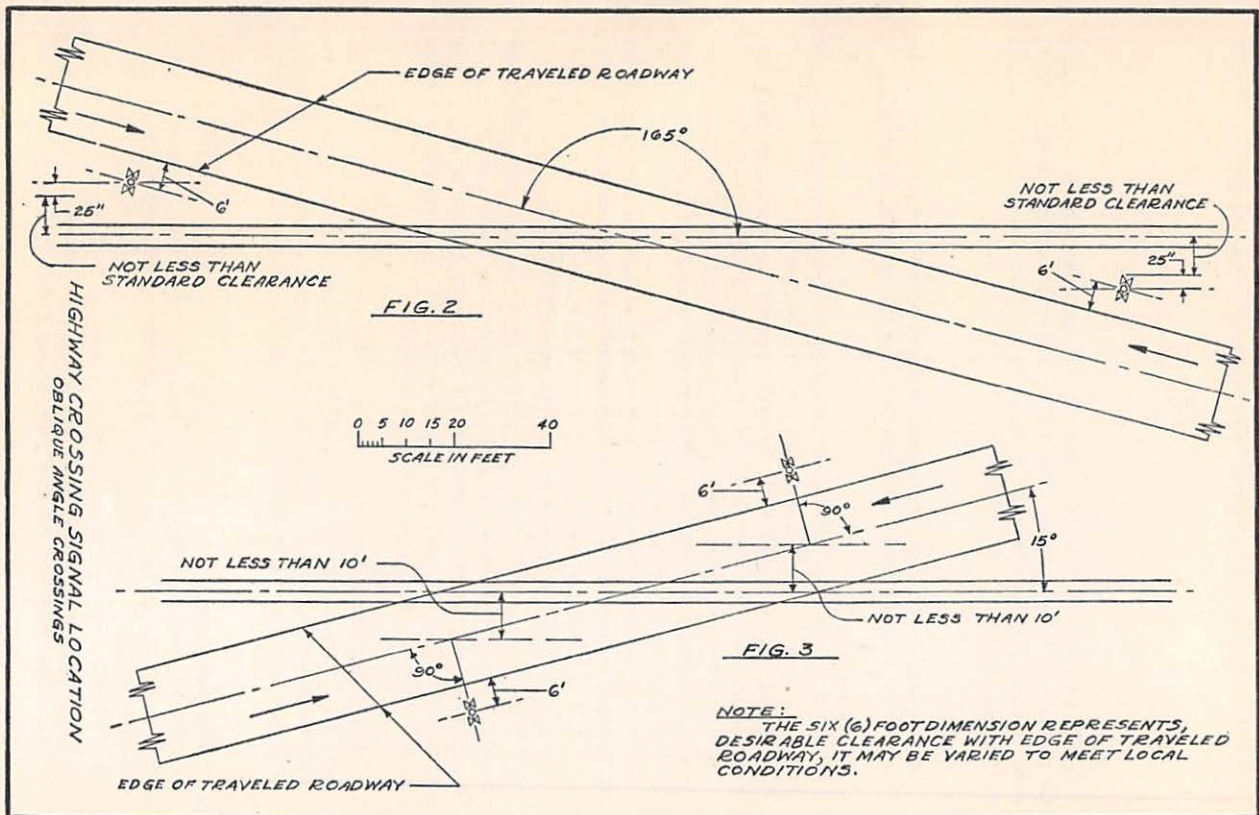
Action Recommended

Acceptance as information.



NOTE:
THE SIX (6) FOOT DIMENSION REPRESENTS,
DESIRABLE CLEARANCE WITH EDGE OF TRAVELED
ROADWAY, IT MAY BE VARIED TO MEET LOCAL
CONDITIONS.

HIGHWAY CROSSING SIGNAL LOCATION
RIGHT ANGLE CROSSINGS



A.A.R. SIGNAL SECTION REQUISITES.

EQUAL TIMING OF OPERATION OF AUTOMATIC HIGHWAY
GRADE CROSSING PROTECTION DEVICES

1948

1. *Purpose.*

(a) The purpose of these requisites is to set forth the general requirements for providing a type of circuit control that will cause highway grade crossing signal devices to indicate for an approximately equal time for all trains operated over the crossing.

2. *Timing.*

(a) Timing of operation shall be considered approximately equal if the difference between maximum and minimum is not more than 25 seconds.

3. *Circuit control.*

(a) Circuit control shall provide equal timing for predetermined train speed limits within the ratio of 1 to 4 for low speed to high speed.

(b) Circuit control shall include the use of a positive operating track section or sections to insure minimum operating time of signal devices.

(c) Where operating rules prohibit train acceleration within the limits of the automatic controls, no provision shall be made for circuit control modifications to incorporate corrections for acceleration.

(d) Where operating rules are not applicable to prohibit acceleration, circuit controls shall make provision for the following rates of acceleration:

1. 1.0 M.P.H. per second for 0 to 50 M.P.H. speeds.

2. 0.4 M.P.H. per second for speeds above 50 M.P.H.

(e) Where local conditions require regular operating train stops that may extend the warning times for automatic signal devices, and where the control system makes no automatic provision for uniformity in timing under these conditions, additional circuit controls by automatic, auto-manual or manual devices should be given consideration as required.

4. *Design of control devices.*

(a) The design of control devices shall be such as to insure proper operation during unfavorable weather conditions, and if out of order shall insure the operation of the automatic devices for not less than the minimum operating time.

5. *Timing sections.*

(a) Train speeds shall be measured by one or more train operated timing sections as determined by local conditions and the operating characteristics of the control devices.

(b) The train operated timing section or sections shall be located for approach operation immediately preceding the section which has been established to provide minimum warning time for specified train speeds.

Action Recommended

Acceptance for submission to letter ballot.

COMMITTEE IX—OVERHEAD AND UNDERGROUND LINES

Personnel

G. C. Felton, Chairman	
J. S. Webb, Vice-Chairman	
W. W. Beard	J. D. Jones
F. W. Bender	R. H. Smedley
H. H. Cooper	V. O. Smeltzer
J. J. Corcoran	E. G. Stradling
E. Winans	

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Specification for single and multiple-conductor, rubber-insulated, synthetic sheath cable.
4. Specification for synthetic sheath for insulated wire and cable.
5. Investigate and report on the various types of coverings for line wires now available.
6. Investigate and report on improved methods of splicing signal line wires, and making terminal and branch connections.

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Specification 145-40, Manual Part 20.
- Revision of Specification 89-40, Manual Part 25.
- Revision of Specification 90-40, Manual Part 26.
- Revision of Specification 91-40, Manual Part 28.
- Revision of Specification 161-40, Manual Part 36.
- Revision of Specification 168-40, Manual Part 173.
- Revision of Specification 167-41, Manual Part 180.
- Revision of Specification 196-40, Manual Part 181.
- Revision of Specification 169-40, Manual Part 182.
- Revision of Specification 111-40, Manual Part 186.
- Revision of Specification 3613, Manual Part 39.
- Revision of Specification 3713, Manual Part 40.
3. Specification 239-48.
4. Specification 240-48.
5. Various types of coverings for line wires now available.
6. Improved methods of splicing signal line wires and making terminal and branch connections.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 17, 1948.

Information

Specifications, etc. of other organizations referred to in the report of this Committee may be procured from the following:

A.S.A.—American Standards Association, 70 E. 45 St., New York 17, N. Y.

A.S.T.M.—American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Disposition of 1947 Letter Ballot Subjects

Specification 223-47—Splices in Rubber-Insulated Conductors and Cables—
Now in Manual Part 238.

Specification for Pole Line Hardware—Now in Manual Part 51.

Specification 108-47—Copper Bond Wire—Now in Manual Part 175.

Specification 70-47—Forty Per Cent Conductivity Copper-Covered Steel
Bonding Wire—Now in Manual Part 176.

(Revision of A.A.R. Signal Section Specification 145-40)
A.A.R. SIGNAL SECTION SPECIFICATION 145-48.

SINGLE AND MULTIPLE-CONDUCTOR, INSULATED,
LEAD-COVERED PARKWAY CABLE, ARMORED
WITH FLAT STEEL OR ZINC TAPE

Present

1. *Purpose.*

(a) This specification is for the purpose of providing for single and multiple-conductor, rubber-insulated, lead-covered parkway signal cable with flat metallic tape armor for use on circuits rated at 0-600 and 601-2500 volts. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

5. *Conductor.*

(a) The conductor shall be of soft annealed copper, properly tinned, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 and D 27, sections pertaining to "Conductor," and as required by this specification.

6. *Insulation.*

(a) Conductors shall be individually insulated with a properly vulcanized rubber compound known as Class AO, 30 per cent Hevea rubber, which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where the insulation is applied in more than one layer, adjacent layers shall be vulcanized into a homogeneous mass.

Proposed

1. *Purpose.*

(a) This specification is for the purpose of providing for single and multiple-conductor, insulated, lead-covered parkway signal cable with flat metallic tape armor for use on circuits rated at 0-600 and 601-2500 volts. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

5. *Conductor.*

(a) The conductor shall be of soft or annealed copper, properly tinned or lead-alloy coated, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 or B 189, and D 27-46T, sections pertaining to "Conductor," and as required by this specification.

6. *Insulation.*

(a) Conductor shall be individually insulated with a properly vulcanized synthetic rubber-like compound which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where insulation is applied in more than one layer, adjacent layers shall be vulcanized into a homogeneous mass. The insulation shall be in accordance with A.S.T.M. Specification D 27-46T, sections pertaining to "Insulation," except as modified

*Present*6. *Insulation.*—Continued.

(b) The insulation shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. current Specification D 27, sections pertaining to "Insulation."

(c) The insulating compound shall be clean stripping, leaving the tinned conductor unimpaired and ready for soldering.

*Proposed*6. *Insulation.*—Continued.

by this specification. Sections 9, 10, 11 and 13 of Specification D 27-46T do not apply. The insulation shall be in accordance with the following minimum performance requirements:

1. Physical properties:

Tensile strength,
min. psi..... 850
Elongation at rupture,
min. per cent..... 300
Set in 2 in. gage
length, min. in..... $\frac{1}{2}$

Depreciation in
tensile strength and
elongation after 96
hours in oxygen pressure
test, max. per
cent..... 35

2. Insulation resistance
shall be not less than 30 per
cent of that shown in Table
III of A.S.T.M. Specification
D 27-46T.

3. The thickness of the insulation shall be thickness A or D of Table I, as specified by the Purchaser.

(Table I, without change, from present section 6-d to follow here)

*R-6-a.

(b) Eliminate—covered in proposed section 6-a above.

(c) relettered (b) and changed to read: The insulating compound shall be clean stripping, leaving the coated conductor unimpaired and ready for soldering.

* Alternate requisites section.

*Present*6. *Insulation.*—Continued.

(d) The thickness of the insulation, which thickness shall be in accordance with that shown in Table I, shall be specified by the Purchaser.

(Table I, without change, to be retained, following proposed section 6-a.)

7. *Assembly.*

(a) Cable of more than two conductors shall be made by assembling individual and twisted pairs of conductors into a tight cylindrical form, covering assembly with rubber-filled cable tape and then with a lead sheath. Over the lead sheath shall be laid a layer of impregnated jute bedding and then armor and outer covering. Individual and twisted pairs of conductors shall be assembled helically with adjacent layers wound in opposite direction. One conductor in each layer shall be taped or otherwise suitably marked to serve as a tracer.

(e) Soft or unvulcanized rubber fillers reinforced with twine shall be used to fill interstices if necessary to make cable round. Fillers shall be used for all interstices except those requiring a filler smaller than $\frac{5}{64}$ inch in diameter. Fillers shall be able to shape themselves to completely fill interstices.

8. *Rubber-filled cable tape.*

(a) Rubber-filled tape and the method of its application shall be in accordance with A.S.T.M. current Specification D 27, sections pertaining to "Cable Tape."

*Proposed*6. *Insulation.*—Continued.

(d) Eliminate—thickness specified in proposed section 6-a above.

7. *Assembly.*

(a) Multiple conductor cables shall be made by assembling individual and twisted pairs of insulated conductors into a tight cylindrical form, covering assembly with compound-filled cable tape and then with a lead sheath. Over the lead sheath shall be laid a layer of impregnated jute bedding and then armor and outer covering. Individual and twisted pairs of conductors shall be assembled helically with adjacent layers wound in opposite direction. One conductor in each layer shall be taped or otherwise suitably marked to serve as a tracer.

(e) Soft or unvulcanized rubber-like fillers with or without reinforcing twine shall be used to fill interstices if necessary to make cable round. Fillers shall be used for all interstices except those requiring a filler smaller than $\frac{5}{64}$ inch in diameter. Fillers shall be able to shape themselves to completely fill interstices.

8. *Cable tape.*

(a) Compound-filled tape and the method of its application shall be in accordance with A.S.T.M. current Specification D 27, sections pertaining to "Cable Tape."

*Present*17. *Packing.*

(b) The cable shall be shipped on substantially constructed reels that are of suitable size and in good condition. The reels shall be properly lagged.

Alternate requisites.

R-10-b.

Flat metallic tapes shall be of rolled zinc of grade designated as "Type A, Soft." Width of zinc tapes shall be the same as given for flat steel armor. Thickness of zinc tapes shall be 0.024 in. for cable having diameter under jute bedding of 0-1.000 in. and 0.036 in. for larger diameters.

*Proposed*17. *Packing.*

(b) The cable shall be shipped on substantially constructed reels that are of suitable size and in good condition. The reels shall be properly lagged or otherwise protected.

Alternate requisites.

New section R-6-a to be added as follows:

1. Conductors shall be individually insulated with a properly vulcanized rubber compound known as Class AO, 30 per cent Hevea rubber, and shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. Specification D 27-46T, sections pertaining to "Insulation."

2. The thickness of the insulation shall be in accordance with Table I, as specified by the Purchaser.

R-10-b.

1. Flat metallic tapes shall be of rolled zinc of grade designated as "Type A, Soft." Width of zinc tapes shall be the same as given for flat steel armor. Thickness of zinc tapes shall be 0.024 in. for cable having diameter under jute bedding of 0-1.000 in. and 0.036 in. for larger diameters.

2. Flat metallic tapes shall be galvanized mild steel.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 1, 5-a, 6, 7-a, 7-e, 8, 17-b and alternate requisites section R-10-b of Specification 145-40—Single and Multiple-Conductor, Rubber-Insulated, Lead-Covered Parkway Cable Armored with Flat Steel or Zinc Tape, Manual Part 20.

(Revision of A.A.R. Signal Section Specification S9-40)
A.A.R. SIGNAL SECTION SPECIFICATION S9-48.

**MULTIPLE-CONDUCTOR INSULATED CABLE WITH
WEATHER-RESISTANT OR FLAME-RETARDING
MOISTURE-RESISTANT BRAID COVERING**

Present

1. *Purpose.*

(a) This specification is for the purpose of providing for multiple-conductor, rubber-insulated cable with weather-resistant braid covering for use as aerial cable or as an alternate flame-retarding, moisture-resistant braid covering for use in weather-protected locations and on circuits rated at 0-600 and 601-2500 volts. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

5. *Conductor.*

(a) The conductor shall be of soft annealed copper, properly tinned, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 and D 27, sections pertaining to "Conductor," and as required by this specification.

6. *Insulation.*

(a) Conductors shall be individually insulated with a properly vulcanized rubber compound known as Class AO, 30 per cent Hevea rubber, which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where the insulation is applied in more than one layer, adjacent layers shall be

Proposed

1. *Purpose.*

(a) This specification is for the purpose of providing for multiple-conductor insulated cable with weather-resistant braid covering for use as aerial cable or as an alternate flame-retarding, moisture-resistant braid covering for use in weather-protected locations and on circuits rated at 0-600 and 601-2500 volts. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

5. *Conductor.*

(a) The conductor shall be of soft or annealed copper, properly tinned or lead-alloy coated, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 or B 189, and D 27-46T, sections pertaining to "Conductor," and as required by this specification.

6. *Insulation.*

(a) Conductors shall be individually insulated with a properly vulcanized synthetic rubber-like compound which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where insulation is applied in more than one layer, adjacent layers shall be vulcanized into a homogeneous

Present

6. *Insulation*.—Continued.
vulcanized into a homogeneous mass.

Proposed

6. *Insulation*.—Continued.
mass. The insulation shall be in accordance with A.S.T.M. Specification D 27-46T, sections pertaining to "Insulation," except as modified by this specification. Sections 9, 10, 11 and 13 of Specification D 27-46T do not apply. The insulation shall be in accordance with the following minimum performance requirements:

1. Physical properties:

Tensile strength,	
min. psi.....	850
Elongation at rupture, min. per cent.....	300
Set in 2 in. gage length, min. in.....	$\frac{1}{2}$
Depreciation in tensile strength and elongation after 96 hours in oxygen pressure test, max. per cent.....	35

2. Insulation resistance shall be not less than 30 per cent of that shown in Table III of A.S.T.M. Specification D 27-46T.

3. The thickness of the insulation shall be thickness A or D of Table I, as specified by the Purchaser.

(Table I, without change, from present section 6-d to follow here)

*R-6-a.

(b) The insulation shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. current Specification D27, sections pertaining to "Insulation."

- (b) Eliminate—covered in proposed section 6-a above.

* Alternate requisites section.

*Present*6. *Insulation.*—Continued.

(c) The insulating compound shall be clean stripping, leaving the tinned conductor unimpaired and ready for soldering.

(d) The thickness of the insulation, which thickness shall be in accordance with that shown in Table I, shall be specified by the Purchaser.

(Table I, without change, to be retained, following proposed section 6-a.)

7. *Assembly.*

(a) Cable of more than two conductors shall be made by assembling individual and twisted pairs of rubber-insulated conductors into a tight cylindrical form, covering assembly with rubber-filled cable tape and then with a weatherproof braid covering. Individual and twisted pairs of conductors shall be assembled helically with adjacent layers wound in opposite direction. One conductor in each layer shall be taped or otherwise suitably marked to serve as a tracer.

(e) Soft or unvulcanized rubber fillers reinforced with twine shall be used to fill interstices if necessary to make cable round. Fillers shall be used for all interstices except those requiring a filler smaller than $\frac{5}{64}$ inch in diameter. Fillers shall be able to shape themselves to completely fill interstices.

*Proposed*6. *Insulation.*—Continued.

(c) relettered (b) and changed to read: The insulating compound shall be clean stripping, leaving the coated conductor unimpaired and ready for soldering.

(d) Eliminate—thickness specified in proposed section 6-a above.

7. *Assembly.*

(a) Multiple-conductor cables shall be made by assembling individual and twisted pairs of insulated conductors into a tight cylindrical form covering assembly with compound-filled cable tape, and then with a weatherproof braid covering. Individual and twisted pairs of conductors shall be assembled helically with adjacent layers wound in opposite direction. One conductor in each layer shall be taped or otherwise suitably marked to serve as a tracer.

(e) Soft or unvulcanized rubber-like fillers with or without reinforcing twine shall be used to fill interstices if necessary to make cable round. Fillers shall be used for all interstices except those requiring a filler smaller than $\frac{5}{64}$ inch in diameter. Fillers shall be able to shape themselves to completely fill interstices.

*Present*14. *Packing.*

(b) The cable shall be shipped on substantially constructed reels that are of suitable size and in good condition. The reels shall be properly lagged.

*Proposed*14. *Packing.*

(b) The cable shall be shipped on substantially constructed reels that are of suitable size and in good condition. The reels shall be properly lagged or otherwise protected.

Alternate requisites.

New section R-6-a to be added as follows:

1. Conductors shall be individually insulated with a properly vulcanized rubber compound known as Class AO, 30 per cent Hevea rubber, and shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. Specification D 27-46T, sections pertaining to "Insulation."

2. The thickness of the insulation shall be in accordance with Table I, as specified by the Purchaser.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 1, 5-a, 6, 7-a, 7-e and 14-b of Specification 89-40—Multiple-Conductor Rubber-Insulated Cable with Weather-Resistant or Flame-Retarding Moisture-Resistant Braid Covering, Manual Part 25.

(Revision of A.A.R. Signal Section Specification 90-40)
A.A.R. SIGNAL SECTION SPECIFICATION 90-48.

MULTIPLE-CONDUCTOR INSULATED SUBMARINE CABLE,
LEAD SHEATHED AND ROUND STEEL ARMORED

Present

1. *Purpose.*

(a) This specification is for the purpose of providing for multiple-conductor, rubber-insulated submarine signal cable having lead sheath and round steel armor for use on circuits rated at 0-600 and 601-2500 volts. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

5. *Conductor.*

(a) The conductor shall be of soft annealed copper, properly tinned, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 and D 27, sections pertaining to "Conductor," and as required by this specification.

6. *Insulation.*

(a) Conductors shall be individually insulated with a properly vulcanized rubber compound known as Class AO, 30 per cent Hevea rubber, which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where the insulation is applied in more than one layer, adjacent layers shall be vulcanized into a homogeneous mass.

Proposed

1. *Purpose.*

(a) This specification is for the purpose of providing for multiple-conductor insulated submarine signal cable having lead sheath and round steel armor for use on circuits rated at 0-600 and 601-2500 volts. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

5. *Conductor.*

(a) The conductor shall be of soft or annealed copper, properly tinned or lead-alloy coated, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 or B 189, and D 27-46T, sections pertaining to "Conductor," and as required by this specification.

6. *Insulation.*

(a) Conductors shall be individually insulated with a properly vulcanized synthetic rubber-like compound which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where insulation is applied in more than one layer, adjacent layers shall be vulcanized into a homogeneous mass. The insulation shall be in accordance with A.S.T.M. Specification D 27-46T, sections pertaining to "Insulation," except as modified

*Present*6. *Insulation.*—Continued.

(b) The insulation shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. current Specification D 27, sections pertaining to "Insulation."

(c) The insulating compound shall be clean stripping, leaving the tinned conductor unimpaired and ready for soldering.

*Proposed*6. *Insulation.*—Continued.

by this specification. Sections 9, 10, 11 and 13 of Specification D 27-46T do not apply. The insulation shall be in accordance with the following minimum performance requirements:

1. Physical properties:

Tensile strength,
 min. psi..... 850

Elongation at rupture, min. per cent..... 300

Set in 2 in. gage
 length, min. in..... $\frac{1}{2}$

Depreciation in
 tensile strength and
 elongation after 96
 hours in oxygen pressure
 test, max. per
 cent..... 35

2. Insulation resistance
 shall be not less than 30 per
 cent of that shown in Table
 III of A.S.T.M. Specification
 D 27-46T.

3. The thickness of the insulation shall be thickness A or D of Table I, as specified by the Purchaser.

(Table I, without change, from present section 6-d to follow here)

*R-6-a.

(b) Eliminate—covered in proposed section 6-a above.

(c) relettered (b) and changed to read: The insulating compound shall be clean stripping, leaving the coated conductor unimpaired and ready for soldering.

* Alternate requisites section.

*Present*6. *Insulation.*—Continued.

(d) The thickness of the insulation, which thickness shall be in accordance with that shown in Table I, shall be specified by the Purchaser.

(Table I, without change, to be retained, following proposed section 6-a.)

7. *Assembly.*

(a) Multiple-conductor cable shall be made by assembling individual and twisted pairs of conductors into a tight cylindrical form, covering assembly with rubber-filled cable tape and then with a lead sheath. Over the lead sheath shall be laid a layer of impregnated jute bedding, then the round steel armor. An outside layer of impregnated jute covering shall be laid over the round steel armor. Individual and twisted pairs of conductors shall be assembled helically with adjacent layers wound in opposite direction. One conductor in each layer shall be taped or otherwise suitably marked to serve as a tracer.

(d) Soft or unvulcanized rubber fillers reinforced with twine shall be used to fill interstices if necessary to make cable round. Fillers shall be used for all interstices except those requiring a filler smaller than $\frac{5}{64}$ inch in diameter. Fillers shall be able to shape themselves to completely fill interstices.

8. *Rubber-filled cable tape.*

(a) Rubber-filled tape and the method of its application shall be in accordance with A.S.T.M. current Specification D 27, sections pertaining to "Cable Tape."

*Proposed*6. *Insulation.*—Continued.

(d) Eliminate—thickness specified in proposed section 6-a above.

7. *Assembly.*

(a) Multiple-conductor cable shall be made by assembling individual and twisted pairs of conductors into a tight cylindrical form, covering assembly with compound-filled cable tape and then with a lead sheath. Over the lead sheath shall be laid a layer of impregnated jute bedding, then the round steel armor. An outside layer of impregnated jute covering shall be laid over the round steel armor. Individual and twisted pairs of conductors shall be assembled helically with adjacent layers wound in opposite direction. One conductor in each layer shall be taped or otherwise suitably marked to serve as a tracer.

(d) Soft or unvulcanized rubber-like fillers with or without reinforcing twine shall be used to fill interstices if necessary to make cable round. Fillers shall be used for all interstices except those requiring a filler smaller than $\frac{5}{64}$ inch in diameter. Fillers shall be able to shape themselves to completely fill interstices.

8. *Cable tape.*

(a) Compound-filled tape and the method of its application shall be in accordance with A.S.T.M. current Specification D 27, sections pertaining to "Cable Tape."

*Present*16. *Packing.*

(b) The cable shall be shipped on substantially constructed reels that are of suitable size and in good condition. The reels shall be properly lagged.

*Proposed*16. *Packing.*

(b) The cable shall be shipped on substantially constructed reels that are of suitable size and in good condition. The reels shall be properly lagged or otherwise protected.

Alternate requisites.

New section R-6-a to be added as follows:

1. Conductors shall be individually insulated with a properly vulcanized rubber compound known as Class AO, 30 per cent Hevea rubber, and shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. Specification D 27-46T, sections pertaining to "Insulation."

2. The thickness of the insulation shall be in accordance with Table I, as specified by the Purchaser.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 1, 5-a, 6, 7-a, 7-d, 8 and 16-b of Specification 90-40—Multiple-Conductor, Rubber-Insulated, Submarine Cable, Lead Sheathed and Round Steel Armored, Manual Part 26.

(Revision of A.A.R. Signal Section Specification 91-40)
A.A.R. SIGNAL SECTION SPECIFICATION 91-48.

SINGLE AND MULTIPLE-CONDUCTOR
INSULATED LEAD SHEATHED CABLE

Present

1. *Purpose.*

(a) This specification is for the purpose of providing for single and multiple-conductor, rubber-insulated, lead sheathed signal cable for use on circuits rated at 0-600 and 601-2500 volts. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

5. *Conductor.*

(a) The conductor shall be of soft annealed copper, properly tinned, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 and D 27, sections pertaining to "Conductor," and as required by this specification.

6. *Insulation.*

(a) Conductors shall be individually insulated with a properly vulcanized rubber compound known as Class AO, 30 per cent Hevea rubber, which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where the insulation is applied in more than one layer, adjacent layers shall be vulcanized into a homogeneous mass.

Proposed

1. *Purpose.*

(a) This specification is for the purpose of providing for single and multiple-conductor insulated lead sheathed signal cable for use on circuits rated at 0-600 and 601-2500 volts. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

5. *Conductor.*

(a) The conductor shall be of soft or annealed copper, properly tinned or lead-alloy coated, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 or B 189, and D 27-46T, sections pertaining to "Conductor," and as required by this specification.

6. *Insulation.*

(a) Conductors shall be individually insulated with a properly vulcanized synthetic rubber-like compound which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where insulation is applied in more than one layer, adjacent layers shall be vulcanized into a homogeneous mass. The insulation shall be in accordance with A.S.T.M. Specification D 27-46T, sections pertaining to "Insulation," except as modified by this specification.

*Present*6. *Insulation.*—Continued.

(b) The insulation shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. current Specification D 27, sections pertaining to "Insulation."

(c) The insulating compound shall be clean stripping, leaving the tinned conductor unimpaired and ready for soldering.

*Proposed*6. *Insulation.*—Continued.

Sections 9, 10, 11 and 13 of Specification D 27-46T do not apply. The insulation shall be in accordance with the following minimum performance requirements:

1. Physical properties:

Tensile strength,	
min. psi.....	850
Elongation at rupture, min. per cent....	300
Set in 2 in. gage length, min. in.....	1/2
Depreciation in tensile strength and elongation after 96 hours in oxygen pressure test, max. per cent.....	35

2. Insulation resistance shall be not less than 30 per cent of that shown in Table III of A.S.T.M. Specification D 27-46T.

3. The thickness of the insulation shall be thickness A or D of Table I, as specified by the Purchaser.

(Table I, without change, from present section 6-d to follow here)

*R-6-a.

(b) Eliminate—covered in proposed section 6-a above.

(c) relettered (b) and changed to read: The insulating compound shall be clean stripping, leaving the coat-

* Alternate requisites section.

*Present*6. *Insulation.*—Continued.

(d) The thickness of the insulation, which thickness shall be in accordance with that shown in Table I, shall be specified by the Purchaser.

(Table I, without change, to be retained, following proposed section 6-a.)

7. *Assembly.*

(a) Cable of more than two conductors shall be made by assembling individual and twisted pairs of rubber-insulated conductors into a tight cylindrical form, covering assembly with rubber-filled cable tape and then with a lead sheath. Individual and twisted pairs of conductors shall be assembled helically with adjacent layers wound in opposite direction. One conductor in each layer shall be taped or otherwise suitably marked to serve as a tracer.

(e) Soft or unvulcanized rubber fillers reinforced with twine shall be used to fill interstices if necessary to make cable round. Fillers shall be used for all interstices except those requiring a filler smaller than $\frac{5}{64}$ inch in diameter. Fillers shall be able to shape themselves to completely fill interstices.

8. *Rubber-filled cable tape.*

(a) Rubber-filled tape and the method of its application shall be in accordance with A.S.T.M. current Specification D 27, sections pertaining to "Cable Tape."

*Proposed*6. *Insulation.*—Continued.

ed conductor unimpaired and ready for soldering.

(d) Eliminate—thickness specified in proposed section 6-a above.

7. *Assembly.*

(a) Multiple-conductor cables shall be made by assembling individual and twisted pairs of insulated conductors into a tight cylindrical form, covering assembly with compound-filled cable tape and then with a lead sheath. Individual and twisted pairs of conductors shall be assembled helically with adjacent layers wound in opposite direction. One conductor in each layer shall be taped or otherwise suitably marked to serve as a tracer.

(e) Soft or unvulcanized rubber-like fillers with or without reinforcing twine shall be used to fill interstices if necessary to make cable round. Fillers shall be used for all interstices except those requiring a filler smaller than $\frac{5}{64}$ inch in diameter. Fillers shall be able to shape themselves to completely fill interstices.

8. *Cable tape.*

(a) Compound-filled tape and the method of its application shall be in accordance with A.S.T.M. current Specification D 27, sections pertaining to "Cable Tape."

*Present*15. *Packing.*

(b) The cable shall be shipped on substantially constructed reels that are of suitable size and in good condition. The reels shall be properly lagged.

*Proposed*15. *Packing.*

(b) The cable shall be shipped on substantially constructed reels that are of suitable size and in good condition. The reels shall be properly lagged or otherwise protected.

Alternate requisites.

New section R-6-a to be added as follows:

1. Conductors shall be individually insulated with a properly vulcanized rubber compound known as Class AO, 30 per cent Hevea rubber, and shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. Specification D 27-46T, sections pertaining to "Insulation."

2. The thickness of the insulation shall be in accordance with Table I, as specified by the Purchaser.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 1, 5-a, 6, 7-a, 7-c, 8 and 15-b of Specification 91-40—Single and Multiple-Conductor, Rubber-Insulated, Lead Sheathed Cable, Manual Part 28.

(Revision of A.A.R. Signal Section Specification 161-40)
A.A.R. SIGNAL SECTION SPECIFICATION 161-48.

SINGLE AND MULTIPLE-CONDUCTOR, INSULATED,
NON-METALLIC SHEATHED CABLE

Present

1. *Purpose.*

(a) This specification is for the purpose of providing for single and multiple-conductor, rubber-insulated signal cable with non-metallic sheath for installation in direct contact with the earth, in ducts, in the air or in any combinations of these types of installation and on circuits rated at 0-600 and 601-2500 volts. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

5. *Conductor.*

(a) The conductor shall be of soft annealed copper, properly tinned, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 and D 27, sections pertaining to "Conductor," and as required by this specification.

6. *Insulation.*

(a) Conductors shall be individually insulated with a properly vulcanized rubber compound known as Class AO, 30 per cent Hevea rubber, which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where the insulation is applied in more than one layer, adjacent layers shall be vulcanized into a homogeneous mass.

Proposed

1. *Purpose.*

(a) This specification is for the purpose of providing for single and multiple-conductor, insulated signal cable with non-metallic sheath for installation in direct contact with the earth, in ducts, in the air or in any combinations of these types of installation and on circuits rated at 0-600 and 601-2500 volts. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

5. *Conductor.*

(a) The conductor shall be of soft or annealed copper, properly tinned or lead-alloy coated, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 or B 189, and D 27, sections pertaining to "Conductor," and as required by this specification.

6. *Insulation.*

(a) Conductors shall be individually insulated with a properly vulcanized synthetic rubber-like compound which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where insulation is applied in more than one layer, adjacent layers shall be vulcanized into a homogeneous mass. The insulation shall be in accordance with A.S.T.M. Specification

*Present*6. *Insulation.*—Continued.

(b) The insulation shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. current Specification D 27, sections pertaining to "Insulation."

(c) The insulating compound shall be clean stripping, leaving

*Proposed*6. *Insulation.*—Continued.

D 27-46T, sections pertaining to "Insulation," except as modified by this specification. Sections 9, 10, 11 and 13 of Specification D 27-46T do not apply. The insulation shall be in accordance with the following minimum performance requirements:

1. Physical properties:

Tensile strength,	
min. psi.....	850
Elongation at rupture, min. per cent....	300
Set in 2 in. gage length, min. in.....	$\frac{1}{2}$
Depreciation in tensile strength and elongation after 96 hours in oxygen pressure test, max. per cent.....	35

2. Insulation resistance shall be not less than 30 per cent of that shown in Table III of A.S.T.M. Specification D 27-46T.

3. The thickness of the insulation shall be thickness A or D of Table I, as specified by the Purchaser.

(Table I, without change, from present section 6-d to follow here)

*R-6-a.

(b) Eliminate—covered in proposed section 6-a above.

(c) relettered (b) and changed to read: The insulating

* Alternate requisites section.

*Present*6. *Insulation.*—Continued.

the tinned conductor unimpaired and ready for soldering.

(d) The thickness of the insulation, which thickness shall be in accordance with that shown in Table I, shall be specified by the Purchaser.

(Table I, without change, to be retained, following proposed section 6-a.)

7. *Assembly.*

(a) Cable shall be made by assembling individual and twisted pairs of rubber-insulated conductors into a tight cylindrical form and covering assembly with a moisture seal rubber sheath, over which is placed a rubber-filled cable tape, a layer of compound and an outer moisture, acid, alkali and flame-resistant sisal braid covering coated with mica flake. Individual and twisted pairs of conductors in a cable, having more than two conductors shall be assembled helically and with adjacent layers wound in opposite direction. One conductor in each layer shall be taped or otherwise suitably marked to serve as a tracer.

(e) Soft or unvulcanized rubber fillers reinforced with twine shall be used to fill interstices if necessary to make cable assembly round. Fillers shall be used for all interstices except those requiring a filler smaller than $\frac{5}{64}$ inch in diameter. Fillers shall be able to shape themselves to completely fill interstices and if unvulcanized shall be vulcanized when moisture

*Proposed*6. *Insulation.*—Continued.

compound shall be clean stripping, leaving the coated conductor unimpaired and ready for soldering.

(d) Eliminate—thickness specified in proposed section 6-a above.

7. *Assembly.*

(a) Cable shall be made by assembling individual and twisted pairs of insulated conductors in a tight cylindrical form and covering assembly with a moisture seal sheath over which is placed a compound-filled cable tape, a layer of compound and an outer moisture, acid, alkali and flame-resistant sisal braid covering coated with mica flake. Individual and twisted pairs of conductors in a cable, having more than two conductors shall be assembled helically and with adjacent layers wound in opposite direction. One conductor in each layer shall be taped or otherwise suitably marked to serve as a tracer.

(e) Soft or unvulcanized rubber-like fillers with or without reinforcing twine shall be used to fill interstices if necessary to make cable assembly round. Fillers shall be used for all interstices except those requiring a filler smaller than $\frac{5}{64}$ inch in diameter. Fillers shall be able to shape themselves to completely fill interstices and if unvulcanized shall be

Present

7. *Assembly.*—Continued.
seal rubber jacket is vulcanized. Outer interstices in assembled conductors may be filled by moisture seal rubber sheath in place of individual rubber fillers.

8. *Moisture seal rubber sheath.*
(a) A continuous tubular sheath of high tensile strength, moisture-resistant rubber compound shall be tightly formed around the insulated conductors to provide protection against mechanical injury and the entrance of moisture, earth acids and alkalis into the cable. It shall not adhere to insulated conductors.

9. *Rubber-filled cable tape.*
(a) Rubber-filled tape and the method of its application shall be in accordance with A.S.T.M. current Specification D 27, sections pertaining to "Cable Tape."

10. *Outer covering.*
(a) Over rubber-filled cable tape shall be placed a layer of compound of oxidized bituminous material and suitable mineral filler. Compound shall have resistance to moisture, acids and alkalis; a softening point accord-

Proposed

7. *Assembly.*—Continued.
vulcanized when moisture seal rubber jacket is vulcanized. Outer interstices in assembled conductors may be filled by moisture seal rubber sheath in place of individual rubber fillers.

8. *Moisture seal sheath.*
(a) A continuous tubular sheath of high tensile strength, moisture-resistant, properly vulcanized polychloroprene compound shall be tightly formed around the insulated conductors to provide protection against mechanical injury and the entrance of moisture, earth acids and alkalis into the cable. It shall not adhere to insulated conductors of multiple-conductor cables. The polychloroprene compound sheath shall be in accordance with A.S.T.M. current Specification D 752, except as modified by this specification. The moisture seal sheath shall not absorb moisture in excess of 70 milligrams per square inch of submerged surface by weight.
*R-8-a.

9. *Cable tape.*
(a) Compound-filled tape and the method of its application shall be in accordance with A.S.T.M. current Specification D 27, sections pertaining to "Cable Tape."

10. *Outer covering.*
(a) Over compound-filled cable tape shall be placed a layer of compound of oxidized bituminous material and suitable mineral filler. Compound shall have resistance to moisture, acids and alkalis; a softening point accord-

* Alternate requisites section.

*Present**Proposed*

10. *Outer covering.*—Continued, ing to the ring-and-ball method (A.S.T.M. current Specification D 36) of not less than 175 deg. F., and a temperature susceptibility sufficiently low that the compound will not become brittle at zero deg. F. nor readily migrate at 150 deg. F.

(b) Outer covering shall be made of 32 lbs. Java sisal applied with sufficient ends, carriers and picks per inch to provide approximately 100 per cent surface coverage. The thickness of the braid shall be not less than 0.070 in. If in process of manufacturing repairs are required to the sisal braid, such repairs shall only be made in the braiding machine.

11. *Saturant.*

(a) The outer covering shall be thoroughly saturated with an oxidized bituminous material similar in characteristics to compound over rubber-filled cable tape except that softening point shall be not lower than 145 deg. F. and the mineral filler shall be omitted.

(b) Saturation of sisal braid covering shall be so thorough that no unsaturated ends will be exposed by a diagonal cut through covering.

17. *Acceptance requirements.*

(b) Performance test on moisture seal sheath.

1. Moisture absorption.

(a) Test specimens shall consist of strips of moisture seal rubber sheath approximately 5 inches in length, buffed

10. *Outer covering.*—Continued.

ing to the ring-and-ball method (A.S.T.M. current Specification D 36) of not less than 175 deg. F., and a temperature susceptibility sufficiently low that the compound will not become brittle at zero deg. F. nor readily migrate at 150 deg. F.

(b) Outer covering shall be made of 32-lb. sisal or jute yarn of equivalent size applied with sufficient ends, carriers and picks per inch to provide approximately 100 per cent surface coverage. The thickness of the braid shall be not less than 0.070 in. If in process of manufacturing repairs are required to the sisal braid, such repairs shall only be made in the braiding machine.

11. *Saturant.*

(a) The outer covering shall be thoroughly saturated with an oxidized bituminous material similar in characteristics to compound over compound-filled cable tape except that softening point shall be not lower than 145 deg. F. and the mineral filler shall be omitted.

(b) Saturation of sisal or jute braid covering shall be so thorough that no unsaturated ends will be exposed by a diagonal cut through covering.

17. *Acceptance requirements.*

(b) Performance test on moisture seal sheath.

1. Moisture absorption.

(a) Test specimens shall consist of strips of moisture seal sheath approximately 5 inches in length, buffed to a

*Present*17. *Acceptance requirements.*—
Continued.

to a uniform thickness and so that all corrugations are removed. All wax, tar, threads and other substances adhering to the surfaces shall also be carefully removed and the surfaces thoroughly scrubbed clean with water and a small brush or lintless cloth. Specimens shall then be rinsed and dried by exposing them to circulating air at a temperature of not less than 158 deg. F. or more than 160 deg. F. for a period of 24 hours. The specimens shall be suspended in such a manner that they do not touch each other or the sides of the oven.

(c) Performance tests on completed cable.

1. Bend test.

(b) The moisture seal rubber sheath and sisal outer covering shall not break, nor shall the finishing material flake off the cable during these tests. Cracking of the finish during these tests shall not constitute a failure.

2. Immersion test.

(c) At the end of the 24 hour periods, neither of the entire sheaths of the 2 ft. or the 5 ft. immersed samples shall show more than 5 per

*Proposed*17. *Acceptance requirements.*—
Continued.

uniform thickness and so that all corrugations are removed. All wax, tar, threads and other substances adhering to the surfaces shall also be carefully removed and the surfaces thoroughly scrubbed clean with water and a small brush or lintless cloth. Specimens shall then be rinsed and dried by exposing them to circulating air at a temperature of not less than 158 deg. F. or more than 160 deg. F. for a period of 24 hours. The specimens shall be suspended in such a manner that they do not touch each other or the sides of the oven.

(c) Performance tests on completed cable.

1. Bend test.

(b) The moisture seal sheath and sisal outer covering shall not break, nor shall the finishing material flake off the cable during these tests. Cracking of the finish during these tests shall not constitute a failure.

2. Immersion test.

(c) At the end of the 24 hour periods, neither of the entire sheaths of the 2 ft. or the 5 ft. immersed samples shall show more than 10 per

*Present*17. *Acceptance requirements.*—
Continued.

cent gain in weight after moisture has been removed by a light application of blotting paper.

3. Moisture, acid and alkali test.

(b) After 48 hours immersion none of the samples shall show more than 5 per cent gain in weight computed by formula shown in section 17-c-2-d and after surface moisture has been removed by a light application of blotting paper. Further, the samples shall show no appreciable deterioration as determined by visual examination.

*Proposed*17. *Acceptance requirements.*—
Continued.

cent gain in weight after moisture has been removed by a light application of blotting paper.

3. Moisture, acid and alkali test.

(b) After 48 hours immersion none of the samples shall show more than 10 per cent gain in weight computed by formula shown in section 17-c-2-d and after surface moisture has been removed by a light application of blotting paper. Further, the samples shall show no appreciable deterioration as determined by visual examination.

Alternate requisites.

New section R-6-a to be added as follows:

1. Conductors shall be individually insulated with a properly vulcanized rubber compound known as Class AO, 30 per cent Hevea rubber, and shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. Specification D 27-46T, sections pertaining to "Insulation."

2. The thickness of the insulation shall be in accordance with Table I, as specified by the Purchaser.

<i>Present</i>	<i>Proposed</i>
<i>Alternate requisites.</i> —Continued.	<i>Alternate requisites.</i> —Continued. R-8-a. Moisture seal sheath shall be a properly vulcanized synthetic rubber-like compound in accordance with A.S.T.M. Specification D 866-46T. The moisture seal sheath shall not absorb moisture in excess of 35 milligrams per square inch of submerged surface by weight.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 1, 5-a, 6, 7-a, 7-c, 8-a, 9, 10, 11, 17-b-1-a, 17-c-1-b, 17-c-2-c and 17-c-3-b of Specification 161-40—Single and Multiple-Conductor, Rubber-Insulated, Non-Metallic Sheath Cable, Manual Part 36.

(Revision of A.A.R. Signal Section Specification 168-40)
 A.A.R. SIGNAL SECTION SPECIFICATION 168-48.

COPPER ALLOY WIRE WITH OR WITHOUT WEATHER-RESISTANT COVERING

<i>Present</i>	<i>Proposed</i>
6. <i>Weather-resistant covering.</i> (a) Weather-resistant covering, saturant and finish shall be in accordance with current American Standard C8.18, all sections except those pertaining to "Conductor," issued by the American Standards Association, except that thickness of covering on wire sizes No. 8 and smaller shall be not less than $\frac{3}{64}$ in. and on Nos. 4 and 6 A.W.G. shall be not less than $\frac{1}{64}$ in. *R-6-a.	6. <i>Weather-resistant covering.</i> (a) Weather-resistant covering, saturant and finish shall be in accordance with current American Standard C8.18, all sections except those pertaining to "Conductor," issued by the American Standards Association. *R-6-a. (c) New section to be added as follows: Weather-resistant covering shall be woven braid. *R-6-c.

* Alternate requisites section.

*Present*11. *Acceptance requirements.*

(b) Weight and tolerances.

2. Coverings.

(a) The average weight of the complete covering of weather-resistant wire supplied under this specification, including all fibrous covering, saturant and finish, shall not vary more than 10 per cent over or under the nominal weights given in Table I. The percentage by weight of cotton shall be not less than 30 per cent nor more than 40 per cent of the total weight of the covering. The sample used for this test shall be not less than 2 ft. in length.

3. Finished wire.

(a) The weight of the finished wire shall not vary more than 3 per cent over or under the finished weight prescribed in Table I.

(No change required in Table I)

*Proposed*11. *Acceptance requirements.*

(b) Weight and tolerances.

2. Coverings.

(a) The average weight of the completed covering of weather-resistant wire, including all fibrous covering, saturant and finish, shall be in accordance with current American Standard C8.18, section pertaining to "Weights and Tolerances."

3. Finished wire.

(a) The weight of finished wire in Table I is shown as information.

Alternate requisites.

New section R-6-c to be added as follows:

Weather-resistant covering shall be knitted braid.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 6-a, 11-b-2 and 11-b-3 of Specification 168-40—Copper Alloy Wire With or Without Weather-Resistant Covering, Manual Part 173.

(Revision of A.A.R. Signal Section Specification 167-41)
A.A.R. SIGNAL SECTION SPECIFICATION 167-48.

COPPER-COVERED STEEL WIRE WITH OR WITHOUT WEATHER-RESISTANT COVERINGS

Present

6. *Weather-resistant covering.*

(a) Weather-resistant covering, saturant and finish shall be in accordance with current American Standard C8.18, all sections except those pertaining to "Conductor," issued by the American Standards Association, except that thickness of covering on wires sizes No. 8 A.W.G. and smaller shall be not less than $\frac{3}{64}$ in. and sizes Nos. 4 and 6 A.W.G. shall be not less than $\frac{1}{64}$ in. *R-6-a.

Proposed

6. *Weather-resistant covering.*

(a) Weather-resistant covering, saturant and finish shall be in accordance with current American Standard C8.18, all sections except those pertaining to "Conductor," issued by the American Standards Association. *R-6-a.

(c) New section to be added as follows:

Weather-resistant covering shall be woven braid. *R-6-c.

11. *Acceptance requirements.*

(c) Weight and tolerances.

2. Coverings.

(a) The average weight of the complete covering of weather-resistant wire supplied under this specification, including all fibrous covering, saturant and finish, shall not vary more than 10 per cent over or under the nominal weights given in Table II. The percentage by weight of cotton shall be not less than 30 per cent nor more than 40 per cent of the total weight

11. *Acceptance requirements.*

(c) Weight and tolerances.

2. Coverings.

(a) The average weight of the completed covering of weather-resistant wire, including all fibrous covering, saturant and finish, shall be in accordance with current American Standard C8.18, section pertaining to "Weights and Tolerances."

* Alternate requisites section.

*Present*11. *Acceptance requirements.*—
Continued.

of the covering. The sample used for this test shall be not less than 2 ft. in length.

3. Finished wire.

(a) The weight of finished wire shall not vary more than 3 per cent over or under the finished weight prescribed in Table II.

(No change required in Table II)

*Proposed*11. *Acceptance requirements.*—
Continued.

3. Finished wire.

(a) The weight of finished wire in Table II is shown as information.

Alternate requisites.

New section R-6-c to be added as follows:

Weather-resistant covering shall be knitted braid.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 6-a, 11-c-2 and 11-c-3 of Specification 167-41—Copper-Covered Steel Wire With or Without Weather-Resistant Covering,
Manual Part 180.

(Revision of A.A.R. Signal Section Specification 196-40)
A.A.R. SIGNAL SECTION SPECIFICATION 196-48.COPPER-BEARING STEEL WIRE WITH OR WITHOUT
WEATHER-RESISTANT COVERING*Present**Proposed*6. *Weather-resistant covering.*

(a) Weather-resistant covering, saturant and finish shall be in accordance with current American Standard C8.18, all sections except those pertaining to "Conductor," issued by the American Standards Association except that thickness of covering on wire size No. 9 B.W.G. shall be not less than $\frac{3}{64}$ in. and on wire sizes Nos. 4, 6 and 8 B.W.G. shall be not less than $\frac{1}{64}$ in. *R-6-a.

6. *Weather-resistant covering.*

(a) Weather-resistant covering, saturant and finish shall be in accordance with current American Standard C8.18, all sections except those pertaining to "Conductor," issued by the American Standards Association. *R-6-a.

(c) New section to be added as follows:

Weather-resistant covering shall be woven braid. *R-6-c.

11. *Acceptance requirements.*

(c) Weight and tolerances.

2. Coverings.

(a) The average weight of the complete covering of weather-resistant wire supplied under this specification, including all fibrous covering, saturant and finish, shall not vary more than 10 per cent over or under the nominal weights given in Table I. The percentage by weight of cotton shall be not less than 30 per cent nor more than 40 per cent of the total weight of

11. *Acceptance requirements.*

(c) Weight and tolerances.

2. Coverings.

(a) The average weight of the complete covering including all fibrous covering, saturant and finish, shall not vary more than 10 per cent over or under the nominal weights given in Table I. The percentage by weight of cotton shall be in accordance with current American Standard C8.18. The sample used for this test shall be not less than 2 ft. in length.

* Alternate requisites section.

Present

11. *Acceptance requirements.*—
Continued.

the covering. The sample used for this test shall be not less than 2 ft. in length.

3. Finished wire.

(a) The weight of the finished wire shall not vary more than 3 per cent over or under the finished weight prescribed in Table I.

(No change required in Table I)

Proposed

11. *Acceptance requirements.*—
Continued.

3. Finished wire.

(a) The weight of finished wire in Table I is shown as information.

Alternate requisites.

New section R-6-c to be added as follows:

Weather-resistant covering shall be knitted braid.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 6-a, 11-c-2 and 11-c-3 of Specification 196-40—Copper-Bearing Steel Wire With or Without Weather-Resistant Covering, Manual Part 181.

(Revision of A.A.R. Signal Section Specification 169-40)
A.A.R. SIGNAL SECTION SPECIFICATION 169-48.

HARD-DRAWN COPPER WIRE WITH OR WITHOUT
WEATHER-RESISTANT COVERING

Present

Proposed

6. *Weather-resistant covering.*

(a) Weather-resistant covering, saturant and finish shall be in accordance with current American Standard C8.18, all sections except those pertaining to "Conductor," issued by the American Standards Association, except that thickness of covering on wires sizes No. 8 A.W.G. and smaller shall be not less than $\frac{3}{64}$ in. and sizes Nos. 4 and 6 A.W.G. shall be not less than $\frac{1}{64}$ in.

*R-6-a.

6. *Weather-resistant covering.*

(a) Weather-resistant covering, saturant and finish shall be in accordance with current American Standard C8.18, all sections except those pertaining to "Conductor," issued by the American Standards Association. *R-6-a.

(c) New section to be added as follows:

Weather-resistant covering shall be woven braid. *R-6-c.

11. *Acceptance requirements.*

(b) Conductor tests.

1. Wire shall conform to requirements of A.S.T.M. current Specification B 1, except that an additional variation of 5 per cent will be allowed in the tensile strength of wire to which weather-resistant covering has been applied.

(c) Weight and tolerances.

2. Coverings.

(a) The average weight of the complete covering of wire supplied under this speci-

11. *Acceptance requirements.*

(b) Conductor tests.

1. Wire shall conform to requirements of A.S.T.M. current Specification B 1, except that minimum tensile strength shall be reduced 5 per cent and the minimum elongation shall be reduced in numerical value 0.10 per cent for wire to which weather-resistant covering has been applied.

(c) Weight and tolerances.

2. Coverings.

(a) The average weight of the completed covering of weather-resistant wire, includ-

* Alternate requisites section.

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*Present**Proposed*11. *Acceptance requirements.*—
Continued.

cation, including all fibrous covering, saturant and finish shall not vary more than 10 per cent over or under the nominal weights given in Table I. The percentage by weight of cotton shall be not less than 30 per cent nor more than 40 per cent of the total weight of the covering. The sample used for this test shall be not less than 2 ft. in length.

3. Finished wire.

(a) The weight of the finished wire shall not vary more than 3 per cent over or under the finished weight prescribed in Table I.

(No change in present Table I)

11. *Acceptance requirements.*—
Continued.

ing all fibrous covering, saturant and finish, shall be in accordance with current American Standard C8.18, section pertaining to "Weights and Tolerances."

3. Finished wire.

(a) The weight of finished wire in Table I is shown as information.

Alternate requisites.

New section R-6-c to be added as follows:

Weather-resistant covering shall be knitted braid.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 6-a, 11-b-1, 11-c-2 and 11-c-3 of Specification 169-40—Hard-Drawn Copper Wire With or Without Weather-Resistant Covering, Manual Part 182.

(Revision of A.A.R. Signal Section Specification 111-40)
A.A.R. SIGNAL SECTION SPECIFICATION 111-48.

SINGLE-CONDUCTOR INSULATED WIRE AND CABLE
WITH FLAME-RETARDING, MOISTURE-RESISTANT
OR WEATHER-RESISTANT BRAID COVERING
OR OUTER POLYCHLOROPRENE SHEATH

Present

1. *Purpose.*

(a) This specification is for the purpose of providing for single-conductor, rubber-insulated signal wire and cable with flame-retarding, moisture-resistant braid covering or as an alternate weather-resistant braid covering for use on circuits rated at 0-600 and 601-2500 volts. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

5. *Conductor.*

(a) The conductor shall be of soft annealed copper, properly tinned, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 and D 27, sections pertaining to "Conductor," and as required by this specification.

6. *Insulation.*

(a) Conductor shall be insulated with a properly vulcanized rubber compound known as Class AO, 30 per cent Hevea rubber, which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where the insulation is applied in more than one layer, adjacent layers shall be vulcanized into a homogeneous mass.

Proposed

1. *Purpose.*

(a) This specification is for the purpose of providing for single-conductor insulated signal wire and cable with braid covering or polychloroprene compound outer sheath for use on circuits rated at 0-600 and 601-2500 volts when wire or cable is not in direct contact with the earth. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

5. *Conductor.*

(a) The conductor shall be of soft or annealed copper, properly tinned or lead-alloy coated, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 or B 189, and D 27-46T, sections pertaining to "Conductor," and as required by this specification.

6. *Insulation.*

(a) Conductor shall be individually insulated with a properly vulcanized synthetic rubber-like compound which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where insulation is applied in more than one layer, adjacent layers shall be vulcanized into a homogeneous mass. The insulation shall be in accord-

*Present*6. *Insulation.*—Continued.

(b) The insulation shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. current Specification D 27, sections pertaining to "Insulation."

* Alternate requisites section.

*Proposed*6. *Insulation.*—Continued.

ance with A.S.T.M. Specification D 27-46T, sections pertaining to "Insulation," except as modified by this specification. Sections 9, 10, 11 and 13 of Specification D 27-46T do not apply. The insulation shall be in accordance with the following minimum performance requirements:

1. Physical properties:

Tensile strength,	
min. psi.....	850
Elongation at rupture, min. per cent.....	300
Set in 2 in. gage length, min. in.....	$\frac{1}{2}$
Depreciation in tensile strength and elongation after 96 hours in oxygen pressure test, max. per cent.....	35

2. Insulation resistance shall be not less than 30 per cent of that shown in Table III of A.S.T.M. Specification D 27-46T.

3. The thickness of the insulation shall be thickness A or D of Table I, as specified by the Purchaser.

(Table I, without change, from present section 6-d to follow here)

*R-6-a.

(b) Eliminate—covered in proposed section 6-a above.

*Present*6. *Insulation.*—Continued.

(c) The insulating compound shall be clean stripping, leaving the tinned conductor unimpaired and ready for soldering.

(d) The thickness of the insulation, which thickness shall be in accordance with that shown in Table I, shall be specified by the Purchaser.

(Table I, without change, to be retained, following proposed section 6-a.)

7. *Braid covering and cable tape.*

(a) Cable tape, braid covering, saturant and finish shall be in accordance with Specification 191. *R-7-a.

8. *Identification.*

(a) The wire shall be identified by Manufacturer's National Electric Code marker.

*Alternate requisites.**Proposed*6. *Insulation.*—Continued.

(c) relettered (b) and changed to read: The insulating compound shall be clean stripping, leaving the coated conductor unimpaired and ready for soldering.

(d) Eliminate—thickness specified in proposed section 6-a above.

7. *Outer covering.*

(a) Outer braid covering cable tape, saturant and finish shall be in accordance with Specification 191, Manual Part 201. *R-7-a.

8. *Identification.*

(a) The wire shall be identified by Manufacturer's National Electric Code marker or Manufacturer's name tape.

Alternate requisites.

New section R-6-a to be added as follows:

1. Conductors shall be individually insulated with a properly vulcanized rubber Compound known as Class AO, 30 per cent Hevea rubber, and shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. Specification D 27-46T, sections pertaining to "Insulation."

*Alternate requisites section.

*Present**Proposed**Alternate requisites.—Continued.*

R-7-a.

Braid covering, saturant and finish shall be in accordance with Specification 182.

Alternate requisites.—Continued.

2. The thickness of the insulation shall be in accordance with Table I, as specified by the Purchaser.

R-7-a.

1. Outer braid covering cable tape, saturant and finish shall be in accordance with Specification 182, Manual Part 172.

2. Outer covering shall be a chloroprene compound sheath in accordance with Specification 239, Manual Part Cable tape shall not be used. Electrical tests on wire covered with outer chloroprene compound sheath shall be made on finished wire.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 1, 5-a, 6, 7, 8 and alternate requisites section R-7-a of Specification 111-40—Single-Conductor, Rubber-Insulated Wire and Cable with Flame-Retarding, Moisture-Resistant or Weather-Resistant Braid Covering, Manual Part 186.

A.A.R. SIGNAL SECTION SPECIFICATION 239-48.

**POLYCHLOROPRENE COMPOUND SHEATH FOR
INSULATED WIRE AND CABLE**

1. Purpose.

(a) This specification is for the purpose of providing a polychloroprene compound sheath outer covering on single-conductor, insulated wire and cable for use on signal circuits rated 0-600 and 601-2500 volts when wire or cable is not in direct contact with the earth. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. Material and workmanship.

(a) Material and workmanship shall be first-class in every respect.

3. Sheath.

(a) Sheath shall be a high tensile strength, moisture-resistant properly vulcanized polychloroprene sheath compound conforming to A.S.T.M. current Specification D 752 and meeting the physical requirements of this specification. Tests may be made on a press molded slab of material used in the finished product for determination of the physical requirements of sheath material. Thickness of sheath compound shall be in accordance with Table I.

TABLE I

For Circuits Rated 0-600 Volts

Conductor, size A.W.G.	Nominal thickness of sheath in 64ths of an inch
No. 18 to No. 8	1*
No. 7 to No. 2	2
No. 1 to No. 0000	3

* On conductor size No. 8 A.W.G. where the sheath compound is applied over insulation thickness A, the nominal thickness shall be $\frac{3}{4}$ in.

For Circuits Rated 601-2500 Volts

Conductor, size A.W.G.	Nominal thickness of sheath in 64ths of an inch
No. 14 to No. 6	2
No. 4	3
No. 2 to No. 000	3
No. 0000	4

Note:

The minimum thickness of polychloroprene sheath compound shall be not less than 90 per cent of the specified nominal thickness.

4. *Performance tests.*(a) *Moisture absorption.* *

1. Test specimens shall consist of strips of polychloroprene compound sheath approximately 5 inches in length, buffed to a uniform thickness and so that all corrugations are removed. All wax, tar, threads and other substances adhering to the surfaces shall also be carefully removed and the surfaces thoroughly scrubbed clean with water and a small brush or lintless cloth. Specimens shall then be rinsed and dried by exposing them to circulating air at a temperature of not less than 158 deg. F. or more than 160 deg. F. for a period of 24 hours. The specimens shall be suspended in such a manner that they do not touch each other or the sides of the oven.

2. After removal from the oven, all specimens shall be brought to room temperature as quickly as possible, and then weighed immediately with an accuracy of one part in 10,000.

3. Test specimens shall be completely immersed in a tightly covered vessel containing distilled water and the level of the water maintained at least $\frac{1}{2}$ in. above the top of the specimen. The area of the surface immersed shall be taken as the sum of the areas of the outside and inside surfaces and edges of the specimen, measured with an accuracy of one part in 100. The water shall be maintained at a temperature of not less than 157 deg. F. or more than 159 deg. F. for the period specified.

4. Specimens shall be prepared for weighing by bringing them to room temperature in distilled water. As each specimen is about to be weighed, it shall be removed from the water and the loose water shaken off. It shall be immersed immediately in alcohol for 2 seconds, removed and shaken, and blotted with lintless, absorbent cloth. The alcohol used shall be pure 95 per cent ethyl alcohol, or the same denatured with pure methyl alcohol. (The object of the blotting is to remove the surplus alcohol or water adhering to the surface, and should be accomplished by placing the specimen between loose folds of cloth, employing as little friction or pressure as possible. The blotting process should be completed within 30 seconds after the removal from the alcohol.) The specimen shall be placed on the balance and the weight recorded 3 minutes after removal from the alcohol. The increase in weight shall be taken as the weight of the water absorbed. The water absorption shall be reported in milligrams per square inch of surface immersed.

(b) *Flame-resisting test.*

1. A 10 in. sample of the finished wire or cable, supported in a horizontal position in still air shall have the tip of a $1\frac{1}{2}$ in.

4. *Performance tests.*—Continued.

blue cone in a 5 in. flame from a Tirrill burner having $\frac{3}{8}$ in. bore and a length of 4 in. above the primary inlet brought to play on a point approximately in the center of the sample and held at that point for 30 seconds, then removed. After this application the flame shall not have spread or continued to spread in either direction for a distance greater than 4 in. from the center of the sample at which flame is applied.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 240-48.

SINGLE AND MULTIPLE-CONDUCTOR, INSULATED,
POLYCHLOROPRENE COMPOUND SHEATHED CABLE1. *Purpose.*

(a) This specification is for the purpose of providing for single and multiple-conductor, insulated signal cable with polychloroprene compound sheath for installation in direct contact with the earth, in ducts, in the air or any combinations of these types of installation and on circuits rated 0-600 and 601-2500 volts. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

3. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

5. *Conductor.*

(a) The conductor shall be of soft or annealed copper, properly tinned or lead-alloy coated, and have properties and characteristics in accordance with A.S.T.M. current Specifications B 33 or B 189 and D 27-46T, sections pertaining to "Conductor," and as required by this specification.

(b) Conductor shall be solid for sizes No. 6 A.W.G. and smaller and A.S.T.M. Class B concentric lay stranded for sizes larger than No. 6 A.W.G. *R-5-b.

6. *Insulation.*

(a) Conductors shall be individually insulated with a properly vulcanized synthetic rubber-like compound which shall be homogeneous in character, tough, elastic and applied concentrically about the conductor, and shall fit tightly thereto. Where insulation is applied in more than one layer, adjacent layers shall be vulcanized into a homogeneous mass. The insulation shall be in accordance with A.S.T.M. Specification D 27-46T, sections per-

* Alternate requisites section.

6. *Insulation.*—Continued.

taining to "Insulation," except as modified by this specification. Sections 9, 10, 11 and 13 of Specification D 27-46T do not apply. The insulation shall be in accordance with the following minimum performance requirements (*R-6-a):

1. Physical properties:

Tensile strength, min. psi.....	850
Elongation at rupture, min. per cent.....	300
Set in 2 in. gage length, min. in.....	$\frac{1}{2}$
Depreciation in tensile strength and elongation after 96 hours in oxygen pressure test, max. per cent..	35

2. Insulation resistance shall be not less than 30 per cent of that shown in Table III of A.S.T.M. Specification D27-46T.

(b) The insulating compound shall be clean stripping, leaving the coated conductor unimpaired and ready for soldering.

(c) The thickness of the insulation, which thickness shall be in accordance with thickness A or D of Table I, shall be specified by the Purchaser.

TABLE I

For Circuits Rated 0-600 Volts

Thickness	Size of conductor	Insulation thickness on each conductor, 64ths of an inch	Test voltage
A	No. 14 to No. 8 A.W.G.	5	6,000
	No. 7 to No. 2 A.W.G.	6	7,500
	No. 1 to No. 0000 A.W.G.	7	9,000
B	No. 14 to No. 8 A.W.G.	4	5,000
	No. 7 to No. 2 A.W.G.	5	6,000
	No. 1 to No. 0000 A.W.G.	6	7,500
C	No. 14 to No. 9 A.W.G.	3	3,000
	No. 8 to No. 2 A.W.G.	4	3,500
	No. 1 to No. 0000 A.W.G.	5	4,000

For Circuits Rated 601-2500 Volts

D	No. 14 to No. 8 A.W.G.	10	12,500
	No. 7 to No. 2 A.W.G.	10	12,500
	No. 1 to No. 0000 A.W.G.	10	12,500
E	No. 14 to No. 8 A.W.G.	9	11,000
	No. 7 to No. 2 A.W.G.	9	11,000
	No. 1 to No. 0000 A.W.G.	9	11,000
F	No. 14 to No. 8 A.W.G.	7	9,000
	No. 7 to No. 2 A.W.G.	8	10,000
	No. 1 to No. 0000 A.W.G.	8	10,000

* Alternate requisites section.

7. Assembly.

(a) Multiple-conductor cables shall be made by assembling individual and twisted pairs of insulated conductors into a tight cylindrical form and covering assembly with a polychloroprene compound sheath. Individual and twisted pairs of conductors in a cable having more than two conductors shall be assembled helically and with adjacent layers wound in opposite direction. One conductor in each layer shall be taped or otherwise suitably marked to serve as a tracer.

(b) Two conductor cables shall be made twin with the conductors parallel and the cable oval in form. One conductor shall be taped or otherwise suitably marked to serve as a tracer.

(c) Twisted pairs shall be formed from two individually insulated conductors, one suitably marked for identification, cabled with a length of lay as short as good construction will permit and not longer than 10 in. The length of lay of adjacent pair shall differ by at least $\frac{1}{2}$ in.

(d) Twisted pairs shall be assembled as the center of the cable and individually insulated conductors arranged concentrically about the core thus formed.

(e) Soft or unvulcanized rubber-like fillers with or without reinforcing twine shall be used to fill interstices and if necessary to make cable assembly round. Fillers shall be used for all interstices except those requiring a filler smaller than $\frac{5}{64}$ inch in diameter. Fillers shall be able to shape themselves to completely fill interstices and if unvulcanized shall be vulcanized when polychloroprene compound sheath is vulcanized. Outer interstices in assembled conductors may be filled by polychloroprene compound sheath in place of individual rubber-like fillers.

(f) Where necessary to hold assembled conductors to true form a binding of an open wind of cotton yarn sufficiently strong shall be wound helically, with a lay of not less than $\frac{1}{2}$ in., over assembled conductors. This binding shall permit polychloroprene compound sheath to fill outer interstices not filled by fillers.

8. Outer sheath.

(a) A continuous tubular sheath of high tensile strength moisture-resistant properly vulcanized polychloroprene compound shall be tightly formed around the insulated conductors to provide protection against mechanical injury and the entrance of moisture, earth acids and alkalis into the cable. It shall not adhere to the insulated conductors of multiple-conductor cables. The polychloroprene compound sheath shall be in accordance with A.S.T.M. current Specification D 752, except as modified by this specification. The polychloroprene sheath shall not absorb moisture in excess of 70 milligrams per square inch of submerged surface by weight.

(b) Polychloroprene sheath shall have a thickness in accordance with Table II.

8. *Outer sheath.*—Continued.

TABLE II

Diameter of cable core, in inches	Minimum thickness in 64ths of an inch	
	Single-conductor	Multiple-conductor
0 to 0.425	4	5
0.426 to 0.700	5	6
0.701 to 1.050	6	7
1.051 to 1.500	7	8
1.500 to 2.000	8	10
2.001 to 3.000	9	12
3.001 and larger	10	14

Note:

For twin conductor cables the core diameter shall correspond to major core diameters.

9. *Identification.*

(a) Cable shall be identified by a tape under the polychloroprene compound sheath showing the name of the Manufacturer and the year in which the cable was manufactured or like information formed in the sheath. This information is to appear at intervals of approximately 1 ft.

10. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Contractor shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

11. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Contractor shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order.

12. Samples for test.

(a) One sample shall be taken from the first 5,000 ft. of completed cable or fraction thereof and one from each additional 5,000 ft. or fraction thereof for each of the acceptance tests on completed cable specified, if such tests are requested by the Purchaser.

(b) If the Purchaser intends to test more than this number of samples such intention shall be indicated at the time of asking for quotations.

(c) On orders for less than these quantities, samples and tests shall be made if called for by the Purchaser at the time of asking for quotations.

13. Acceptance requirements.

(a) The finished cable and individual conductors in cable shall withstand successfully the performance tests required by this specification and specifications referred to, which form an integral part of this specification.

(b) Performance test on polychloroprene compound sheath.

1. Moisture absorption.

(a) Test specimens shall consist of strips of polychloroprene compound sheath approximately 5 inches in length, buffed to a uniform thickness and so that all corrugations are removed. All substances adhering to the surfaces shall be carefully removed and the surfaces thoroughly scrubbed clean with water and a small brush or lintless cloth. Specimens shall then be rinsed and dried by exposing them to circulating air at a temperature of not less than 158 deg. F. or more than 160 deg. F. for a period of 24 hours. The specimens shall be suspended in such a manner that they do not touch each other or the sides of the oven.

(b) After removal from the oven, all specimens shall be brought to room temperature as quickly as possible, and then weighed immediately with an accuracy of one part in 10,000.

(c) Test specimens shall be completely immersed in a tightly covered vessel containing distilled water and the level of the water maintained at least $\frac{1}{2}$ in. above the top of the specimen. The area of the surface immersed shall be taken as the sum of the areas of the outside and inside surfaces and edges of the specimen, measured with an accuracy of one part in 100. The water shall be maintained at a temperature of not less than 157 deg. F. or more than 159 deg. F. for the period specified.

(d) Specimens shall be prepared for weighing by bringing them to room temperature in distilled water. As each specimen is about to be weighed, it shall be removed from the water and the loose water shaken off. It shall be immersed immediately in alcohol for 2 sec-

13. *Acceptance requirements.*—Continued.

onds, removed and shaken, and blotted with lintless, absorbent cloth. The alcohol used shall be pure 95 per cent ethyl alcohol, or the same denatured with pure methyl alcohol. (The object of the blotting is to remove the surplus alcohol or water adhering to the surface, and should be accomplished by placing the specimen between loose folds of cloth, employing as little friction or pressure as possible. The blotting process should be completed within 30 seconds after the removal from the alcohol.) The specimen shall be placed on the balance and the weight recorded 3 minutes after removal from the alcohol. The increase in weight shall be taken as the weight of the water absorbed. The water absorption shall be reported in milligrams per square inch of surface immersed.

2. Moisture, acid and alkali test.

(a) One ft. samples of the completed cable with ends completely sealed with asphalt shall be completely immersed at a temperature of approximately 70 deg. F. for a period of 48 hours in each of the solutions specified in Table III.

TABLE III

Solution	Symbol
Distilled water	H ₂ O
Normal solution of sodium hydroxide	NaOH
Saturated solution lime water	Ca(OH) ₂
Solution of sulphuric acid, 5 per cent by volume	H ₂ SO ₄
Solution of acetic acid, 5 per cent by volume	HC ₂ H ₃ O ₂

(b) After 48 hours immersion none of the samples shall show more than 10 per cent gain in weight computed by the following formula and after surface moisture has been removed by a light application of blotting paper. Further, the samples shall show no appreciable deterioration as determined by visual examination.

Formula

Gain in weight of both samples shall be computed as follows:

W = weight of sample before immersion
 W₁ = weight of sample after immersion
 W₂ = weight of insulated conductors and fillers

$$\frac{W_1 - W}{W - W_2} \times 100 = \text{per cent gain}$$

13. *Acceptance requirements.*—Continued.

3. Flame-resisting test.

(a) A 10 in. sample of the finished cable, supported in a horizontal position in still air shall have the tip of a $1\frac{1}{2}$ in. blue cone in a 5 in. flame from a Tirrill burner having $\frac{3}{8}$ in. bore and a length of 4 in. above the primary inlet brought to play on a point approximately in the center of the sample and held at that point for 30 seconds, then removed. After this application the flame shall not have spread or continued to spread in either direction for a distance greater than 4 in. from the center of the sample at which flame is applied.

14. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

(b) The cable shall be shipped on substantially constructed reels that are of suitable size and in good condition. The reels shall be properly lagged or otherwise protected.

(c) Reels shall be provided with cast-iron bushing or iron plate at the center on each side having hole of sufficient size to take shaft suitable for the weight of the cable.

(d) Both ends of the cable shall be available for testing, properly sealed, and protected against injury.

15. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

(c) Reels shall be plainly stenciled with arrow and suitable accompanying wording on each end of reel, indicating which way it shall be rolled, and a full description of the cable showing size and number of conductors, character of insulation, number of feet and gross weight of reel.

16. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace F.O.B. destination of original order (1) any length of cable failing under the acceptance requirements specified herein or during normal or proper use within 1 year of date of installation and (2) any length of cable failing within 2 years from date of installation, which shows defects in material or workmanship, provided in each case immediate written notice of failure is given Contractor. The commence-

16. *Warranty.*—Continued.

ment of such periods in any event to be not more than 6 months from date of shipment of cable. Cables replaced under the provisions of this warranty shall become the property of the Contractor and will be returned to Contractor by the Purchaser F.O.B. destination of original order.

Alternate requisites.

R-5-b.

1. Conductor shall be A.S.T.M. Class B concentric-lay stranded wires sizes No. 2 to 14 A.W.G., inclusive, 7 strands and sizes Nos. 1 to 0000 A.W.G., inclusive, 19 strands..

2. Conductor shall be A.S.T.M. Class C concentric-lay stranded wires sizes Nos. 2 to 14 A.W.G., inclusive, 19 strands and sizes Nos. 1 to 0000 A.W.G., inclusive, 37 strands.

R-6-a.

Conductors shall be individually insulated with a properly vulcanized rubber compound known as Class AO, 30 per cent Hevea rubber, and shall be in accordance with the composition, chemical, physical and electrical requirements for Class AO, 30 per cent Hevea rubber compound specified in A.S.T.M. Specification D 27-46T, sections pertaining to "Insulation."

Action Recommended

Acceptance for submission to letter ballot.

VARIOUS TYPES OF COVERINGS FOR LINE WIRES NOW AVAILABLE*

The following coverings for line wires are now available:

1. Weather-resistant covering in accordance with current American Standard C8.18, which is the weather-resistant covering applying to A.A.R. Signal Section Specifications 169-40, 196-40, 167-41 and 168-40, Manual Parts 182, 181, 180 and 173, respectively.

The following thermoplastic coverings for line wires are now available:

2. Manufacturers' formula Type FF, which is a synthetic enamel applied to the conductor with a form of Polyvinyl-Chloride covering with a total thickness which may vary between 2 to 4 mils.

3. Polyethylene-black covering. The wall thickness of coverings for this type of thermoplastic compound is generally provided in $\frac{3}{64}$ or $\frac{1}{64}$ inch.

The following thermosetting compound for line wires is now available:

4. Neoprene. The wall thickness of coverings for thermosetting compounds is generally provided in $\frac{3}{64}$ or $\frac{1}{64}$ inch.

Action Recommended

Acceptance as information.

IMPROVED METHODS OF SPLICING SIGNAL LINE WIRES, AND MAKING TERMINAL AND BRANCH CONNECTIONS

Comprehensive and complete information on this subject was presented in a paper prepared by Messrs. Hobart Mason, Engineer of Lines, and D. L. Baxter, Engineer, of the Western Union Telegraph Co., entitled "Communication Line Wire Joints," appearing on pages 693-737 of A.A.R. Telegraph and Telephone Section Proceedings, October 1937.

Further investigation of this assignment is being continued.

Action Recommended

Acceptance as information.

* Previous report on this subject appears in A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, p. 263-A.

R.S.A. SPECIFICATION 3613.

STEEL PIPE CONDUIT

The Committee recommends that Specification 3613 be removed from the Manual and superseded by the following reference sheet:

SPECIFICATION FOR STEEL PIPE CONDUIT

1948

The recommended specification for steel pipe conduit is current Specification A 53 of the American Society for Testing Materials.

The recommended specification for metallic coating of metals will be found in Signal Section Manual Part 63.

The recommended specification for pipe thread will be found in Signal Section Manual Part 115.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 3613—Steel Pipe Conduit, Manual Part 39.

R.S.A. SPECIFICATION 3713.

WROUGHT IRON PIPE CONDUIT

The Committee recommends that Specification 3713 be removed from the Manual and superseded by the following reference sheet:

SPECIFICATION FOR WROUGHT IRON PIPE CONDUIT

1948

The recommended specification for wrought iron pipe conduit is current Specification A 72 of the American Society for Testing Materials.

The recommended specification for metallic coating of metals will be found in Signal Section Manual Part 63.

The recommended specification for pipe thread will be found in Signal Section Manual Part 115.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 3713—Wrought Iron Pipe Conduit, Manual Part 40.

COMMITTEE X—SIGNALING PRACTICE

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G. K. Thomas, Vice-Chairman	
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R. D. Moore	C. R. Swenson
H. G. Morgan	C. H. Tillett
L. C. Walters	

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Report on noteworthy changes in signal practices.
4. Recommend uniform signal practice in the use of aspects and indications employing flashing light or lights for railway signaling.
5. Recommend methods of controlling signals in single-track automatic block signal territory.
6. Investigate and report on new signal devices and related appliances.
7. Investigate and report on the utility of highway vehicles in lieu of rail motor cars for railroad signal work.
8. Investigate and report on the safety and economy of approach lighting signals on single and multiple track—"Stop" and "Stop and Proceed" aspects—in advance of and to the rear of a train.

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Signaling for Gravity Classification Yards, Manual Part 42.
Revision of Requisites for Automatic Block Signaling Systems, Manual.
Part 87.
- Revision of Requisites for Interlocking, Manual Part 94.
6. New signal devices and related appliances.
7. Utility of highway vehicles in lieu of rail motor cars for railroad signal work.

Disposition of 1947 Letter Ballot Subjects

Requisites for Protection for Spring Switches—Now in Manual Part 10.

A.A.R. Sig. Sec. 1291A—Sign—End Automatic Block—Now in Drawing
Section of Manual.

A.A.R. Sig. Sec. 1292A—Sign—End of Block—Now in Drawing Section of
Manual.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 17, 1948.

A.A.R. Sig. Sec. 1293A—Signs—Begin CTC & End CTC—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1294A—Sign—End of Circuit—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1295A—Sign—Preliminary Section—Now in Drawing Section of Manual.

Uniform Signal Practice in the Use of Aspects and Indications Employing Flashing Light or Lights for Railway Signaling—Figures 1, 2 and 3—Now in Manual Part 239.

(Revision of Signaling for Gravity Classification Yards)

SIGNALING FOR GRAVITY CLASSIFICATION YARDS

1948

Present

7. Where audible signals are used, in addition to visual signals, their sounds and indications shall be in accordance with Standard Code Rule 606.

Proposed

7. Where audible signals are used, in addition to visual signals, a code of sounds must be used which will provide a distinct indication to correspond to each visual indication, and must not be in conflict with Standard Code Rule 606.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Paragraph 7 of Signaling for Gravity Classification Yards,
Manual Part 42.

(Revision of Requisites for Automatic Block Signaling Systems)
A.A.R. SIGNAL SECTION REQUISITES.

AUTOMATIC BLOCK SIGNALING SYSTEMS

1948

Present

8. The circuits shall be so installed that:

(a) So far as possible, the failure of any part of a circuit affecting the control of a signal will not result in the signal displaying a more favorable indication than intended.

Proposed

8. The circuits shall be so installed that:

(a) As far as practicable, the failure of any part of a circuit affecting the control of a signal will not result in the signal displaying a more favorable indication than intended.

New Requisite 8-c to be added, as follows:

As far as practicable, crossover between main tracks shall be provided with protection that will minimize the possibility of a train, engine or car occupying the crossover and signals on either track displaying other than proper restrictive indication.

(c)

Relettered (d)

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Requisite 8-a of Requisites for Automatic Block Signaling Systems, Manual Part 87.

(Revision of Requisites for Interlocking)
A.A.R. SIGNAL SECTION REQUISITES.

INTERLOCKING

1948

Present

9. Approach or time locking shall be provided in connection with signals governing movements at high or medium speed.

14. Movable bridge shall be equipped with mechanism to surface and align bridge and track accurately and fasten them securely in position.

15. When movable bridge is protected by interlocking, provision shall be made to insure that movements of the bridge devices succeed each other in a predetermined order, and that the movable span, tracks, and switches within interlocking limits are locked in proper positions.

Proposed

9. Approach or time locking, or both, shall be provided in connection with signals governing movements at medium or greater speed. Approach locking shall be continuously effective from a predetermined point in approach of the furthest approach signal, to the home signal.

Eliminate.

Eliminate.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Requisite 9 of Requisites for Interlocking, Manual Part 94.

NEW SIGNAL DEVICES AND RELATED APPLIANCES

Valuable improvements have been made in the field of signal devices within the past year. Biased neutral direct current relays have been developed which afford very important advantages over the usual neutral relay design and provide increased safety. These are available for use in control circuit designs, and also are applicable to track circuit service. Their use on track circuits gives better broken-down insulated joint protection due to their polar characteristics, and lessened response to the effects of foreign current. Other advantages on track circuit applications are better shunting sensitivity and applicability to track circuits up to 6,000 feet in length with ballast resistance down to 3 ohms per thousand feet. A.A.R. Signal Section Specification 228-47, Manual Part 232, covers the details of this type relay.

Another interesting development is a biased neutral controller for electric switch machines, permitting the use of control circuits which are of the two-wire polarized type, and may be normally energized or de-energized, as desired. The controller comprises two biased neutral contactors, and an overload relay, the construction resulting in the elimination of the master relay formerly required to insure the integrity of the response to polarized control. Two contactors, constructed as a unit, are provided with a centering device connecting the two contactor armatures which causes the finger of each contactor to assume a central position between the front and back contacts whenever both contactors are de-energized. Current flowing in a specified direction is required to produce operation of the proper contactor. Voltage of wrong polarity would have to be so great as to far exceed the voltage found in ordinary signal installations, being in the order of 400 times as great as normal pick-up voltage of the device, making it practically immune from false operation from this source.

A new hand-operated switch machine has been developed, having built-in switch locking and circuit controllers. The machine is capable of handling heavy rail with relative ease on the part of the operator, which is accomplished by a drive with high mechanical advantage, and is adaptable to most layouts which are encountered. Additional features, including reverse locking, normal and reverse point detection (with latching feature for the normal position if desired), remote control of locking by mechanical connection, and built-in electric switch locking, may be obtained.

The protection of outlying hand-operated switches by the use of locking devices which prevent the unlocking and operation of a switch until a definite time interval has elapsed, by approach or time locking circuits, has been augmented by a purely mechanical time switch lock which avoids the need for electrical apparatus and sources of power. A time delay is enforced whenever a hand switch is to be operated to allow a train to enter or leave a siding. Control of signal circuits is provided, or track circuits may be shunted, to insure signals displaying proper indications when the device is operated.

Improvements have been noted in the close-up indications of searchlight and other long range color light signals by the use of a new close-up prism which increases the horizontal spread of the close-up beam. This results in better close-up indications for all conditions and especially so when the signal is mounted high and on a curve.

One road has made an installation of centralized traffic control which is controlled on carrier circuits through an underground cable. Several channels are provided for control of the apparatus and also for voice communication. Coded track circuits are employed and in general no line wires are required between sidings, and few, if any, at sidings. Most of the sidings are provided with power-operated switches and signals. The system is arranged so that, in the event of cable or apparatus difficulty, the centralized traffic control code apparatus will be automatically transferred from one carrier system to another which is held for emergency purposes.

Action Recommended

Acceptance as information.

UTILITY OF HIGHWAY VEHICLES IN LIEU OF RAIL MOTOR CARS FOR RAILROAD SIGNAL WORK

The following information was obtained from replies to a questionnaire (Inquiry SS-79A) which was issued February 24, 1948 to Signal Section Voting Representatives of Member Roads. Eighty-two replies were received, thirty-eight of which were blank.

Railroad	Main Line Signal Maintenance			Branch Line Signal Maintenance			Construction		
	No.	Type of Vehicle	Benefits	No.	Type of Vehicle	Benefits	No.	Type of Vehicle	Benefits
1							3	1½ ton trucks	Man hour travel time and time handling material reduced
2							2	1½ ton trucks	Man hour travel time and time handling material reduced
3							1	½ ton truck	Man hour travel time and time handling material reduced
4	1	2-door sedan		3	½ ton trucks	Enables maintainers to reach numerous and scattered highway crossing protection which would be difficult by motor car or train service	1	1½ ton truck	
5	9	Station wagons	Avoids motor car operation through yards. Provides rapid handling of emergencies. More economical handling of material. Less reserve material required	5	Light pick-up trucks	Avoids delays encountered by long motor car trips. Saves expenses away from home station. Provides more productive man hours	10	Heavy trucks	Better material distribution. Increases productive man hours. Decreases hazard due to motor car operation. Improves employee relation
6	13	Jeeps and ½ ton pick-up trucks	Permits continuation of one man territories with increased train schedules and speeds. Enables failures to be cleared in less time	2	Jeeps	Replaces privately owned cars and eliminates necessity of reducing length of maintenance sections	2	Light pick-up trucks	
7							2	Passenger trucks	
							5	1½ ton trucks	Faster transportation of men and materials to point of work and protects men during inclement weather
							1	Jeep	
							3	½ ton trucks	
							1	1 ton truck	Prompt delivery and distribution of material and men to point of work. Reduces waiting time due to train movements

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Signal Section, A.A.R.
Committee X—Signaling Practice

UTILITY OF HIGHWAY VEHICLES IN LIEU OF RAIL MOTOR CARS FOR RAILROAD SIGNAL WORK—Continued

Railroad	Main Line Signal Maintenance			Branch Line Signal Maintenance			Construction		
	No.	Type of Vehicle	Benefits	No.	Type of Vehicle	Benefits	No.	Type of Vehicle	Benefits
8	2	2-door sedans (rented)	1 car assigned to office of Engineer of Signals and Telegraph and 1 car to Signal Supervisors on one division. Allows closer supervision and rapid action in emergency	3	2-door sedan (rented)	Enables more efficient maintenance of branch line scattered installations	1	$\frac{1}{4}$ ton truck (rented)	Allows quick handling of material and saves loss and damage
		(Have approved list of employees who are allowed reimbursement for use of privately owned cars in emergency.)							
9	2	$\frac{1}{2}$ ton pick-up trucks	Less help required and faster service	.....	Same trucks as used for main line	Less help required and faster service	.....	Same trucks as used for maintenance	Less help required and faster service
10	3	$\frac{1}{2}$ ton trucks (privately owned)	Speeds up service. Cost is no more than cars on rails. Increases efficiency	.....	Same trucks as used for main line	Speeds up service. Cost is no more than cars on rails. Increases efficiency	.....		
11							1 1 1	$\frac{1}{4}$ ton truck $\frac{3}{4}$ ton truck 1 ton truck	Jobs are done more economically and quicker than with motor car
12	17 3 45	Trucks Automobiles Automobiles which are privately owned	Expedites handling of men and material as compared with use of motor cars	4	Trucks	Expedites handling of men and material as compared with use of motor cars	26	Trucks	Expedites handling of men and material
13				4	$\frac{1}{2}$ ton trucks	Economical, efficient and saves time	1	$1\frac{1}{2}$ ton truck	Economical, efficient and saves time
14	1 2	Jeep $\frac{3}{4}$ ton trucks	Eliminates delays. Saves 4 man hours per day per track				1	$1\frac{1}{2}$ ton truck	Eliminates delays in transporting material and increases efficiency of construction work
15	3	$\frac{3}{4}$ ton pick-up trucks	Permits covering territory in approximately one-half the time in comparison with motor car. Used in territory that is unusually large and consists mainly of interlocking plants and highway crossing protections	3	Pick-up trucks	Permits covering territory in approximately one-half the time in comparison with motor car. Used in territory that is unusually large and consists mainly of interlocking plants and highway crossing protection	4 1 9	$\frac{3}{4}$ ton trucks 1 ton truck $1\frac{1}{2}$ ton trucks	Saves time moving men and materials

16	6	¾ ton pick-up trucks	Permits more work to be performed by maintainer and more frequent inspection of apparatus	3	¾ ton pick-up trucks	Permits more work to be performed by maintainer and more frequent inspection of apparatus	23	1½-2 ton trucks	Prevents delays on account of traffic. Less hazard. Speeds up work
17	1	1½ ton truck	More flexibility in handling material and men	.....	Same truck as used for main line	More flexibility in handling material and men	.....	Same truck as used for maintenance	More flexibility in handling material and men
18	.....	.....	.....	.....	.....	.....	1	Stake body truck with 5-man cab	Eliminates maintenance of sleeper, living and dining cars and their equipment, and not necessary to provide a cook for the gang. Gang operations are more mobile. Easier to keep men in gangs as they can live at home
19	.....	.....	.....	1 1	Coupe Station car	25% saving on investment	2	1½ ton trucks	Approximately 30% saving on investment
20	2	½ ton trucks (panel body)	Time saving (used by leading maintainers)	5	½ ton trucks (panel body)	Eliminates loss of time waiting for trains	2	¾ ton pick-up trucks	Time saving where highways are accessible
21	5	Automobiles	Used by Signal Supervisors and Assistants to enable them to cover more territory and make more inspections	.....	.....	.....	4	1½ ton trucks	Eliminates hazard of transportation by motor cars. Trucks equipped with derricks and winches for handling material and setting poles
22	1	Ford truck	Avoids necessity of obtaining line-ups on trains. Saves time. Increases safety	1	Ford truck	Avoids long trips on motor cars for outlying highway signal maintenance. Permits larger territory to be assigned to one maintainer	1	1½ ton truck	Avoids necessity of obtaining line-ups on trains. Produces increased efficiency; savings in time transporting men to and from job will soon liquidate cost of trucks
23	.....	.....	.....	.....	.....	.....	2	1½ ton pick-up trucks	Saving of time of transportation of materials and men in terminal areas compared with use of track cars
24	19	½ ton panel trucks	Increased speed in handling men and material in emergencies	.....	Same trucks as used on main line	Most economical and quickest way to reach working point	1 3	1 ton truck 1½ ton trucks	Increased speed in handling men and material. Eliminates delays due to trains
25	1	1 ton truck	Saves time and more material can be handled	.....	(Report for five (5) Same truck as used on main line	railroads under the Management). Saves time and more material can be handled	.....	Same truck as used for maintenance	Saves time and more material can be handled

UTILITY OF HIGHWAY VEHICLES IN LIEU OF RAIL MOTOR CARS FOR RAILROAD SIGNAL WORK—Continued

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Committee X—Signaling Practice

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Railroad	Main Line Signal Maintenance			Branch Line Signal Maintenance			Construction		
	No.	Type of Vehicle	Benefits	No.	Type of Vehicle	Benefits	No.	Type of Vehicle	Benefits
26	1	Truck	Saves time especially in heavy switching districts	.....	.....	.....	1	1 ton truck	Time saved in getting men and material on job. Provides flexible and efficient operation
27	8	½ ton trucks	Reduces motor car travel	.....	.....	.....	4	2½ ton stake body trucks	Reduces motor car travel
28	1	Suburban carry-all	Saves traveling time. Permits carrying a stock of repair parts	1	Suburban carry-all	Saves traveling time. Permits carrying a stock of repair parts	1	Suburban carry-all	Saves traveling time to work. Useful for hauling material
29	.....	.....	.....	.....	.....	.....	4	1½ ton closed body trucks	Expedites distributing material and men from stations where outfit cars can be located. Increases safety. Avoids delays due to heavy rail traffic
30	.....	.....	.....	.....	.....	.....	1 2 6	Station wagon ½ ton trucks 1½ ton trucks	Eliminates delay in hauling men and materials to and from the job
31	1	1 ton truck	Economy and efficiency	.....	Same truck used as for maintenance	Economy and efficiency	.....	Same truck used as for maintenance	Economy and efficiency
32	2	Pick-up trucks with special tool and supply box	Permits larger territory for maintenance men. Permits tools, repair parts and supplies to be carried thereby saving time. Reduces hazard by reduction of number of motor cars on track. Eliminates need of train line-ups and eliminates time loss due to waiting for trains	.....	Same trucks used as for main track	Used in emergency	.....	.....	.....
	4	¾ ton panel body trucks							
33	.....	.....	.....	3	½ ton pick-up trucks	Efficiency	20	1-2 ton trucks owned or rented	Elimination of motor-train accidents. Saving of time. Saving of work train expenses and quicker delivery of material

34	Not given	½ ton pick-up	Economy, efficiency and eliminates keeping men on line over night	.....	Same trucks as used for main track	Economy, efficiency and eliminates keeping men on line over night	.....	½ ton pick-up	Economy, efficiency and eliminates keeping men on line over night
35	1 1	¾ ton truck 2 ton truck	Efficiency, safety and economy	.....					
36	1	Truck	.....	1	Truck	.....			
37	1	Truck	Expedites handling of men to and from the job	.....			1	Truck	Expedites handling of men to and from the job
38							1	Truck	Economy—will pay for truck in 3 or 4 months
39							1	Truck	Economy—will pay for truck in 3 or 4 months
40							1	Evans auto-railer	Greater utilization of man power
41	2	Station wagons	Used by Supervisors to aid in supervision	.....			1 3 6 3 1	Sedan ¾ ton trucks 1½ ton trucks 2 ton trucks 4¾ ton trucks	Time saver
42				1	½ ton truck	Reduction in overtime payments	6	¾ ton trucks	Saving in time and camp car outfits
43	12	3 ton trucks	Transporting men and materials to points not accessible by train service	1 3	½ ton pick-up truck Station wagons	Transporting men and materials to points not accessible by train service	5	3 ton trucks	Transporting men and materials to points not accessible by train service
44	2	2 ton trucks	Used in terminal district only. Economy, efficiency and safety	.....					

Action Recommended

Acceptance as information.

COMMITTEE XI—ELECTRONICS

Personnel

A. B. Armistead, Chairman	
J. I. Kirsch, Vice-Chairman	
E. F. Brown	A. S. Hunt
P. B. Burley	J. W. Jones
T. L. Carlson	L. A. Moll
K. Chamberlain	G. P. Neal
E. A. Dahl	L. A. Sebeczek
J. R. DePriest	H. H. Seifert
L. D. Dickinson	V. O. Smeltzer
L. H. Dyke	N. W. Stickney
H. T. Fleischer	F. A. Tegeler, Jr.
A. J. Hendry	F. T. Warmington
J. M. Hoover	A. V. Dasburg*
R. M. Laurenson*	

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Indexing signal literature.
2. Investigate and report on the use of space and wired electronic systems for signal controls in connection with block signals, interlocking, centralized traffic control, railroad highway grade crossing protection, special signal controls for slide protection, high water, yard track and train indicators, and dragging equipment detectors.
3. Report on electronic measuring apparatus applicable to railroad signaling.
4. Report on various symbols and nomenclature used in electronic systems.
5. Principles of vacuum tubes, carrier systems and other electronic systems and devices.
6. Use of tube rectifiers, including electronic control of rectifiers.
7. Investigate and report on electronic automatic OS systems.
8. Investigate and report on use of electronic devices on trains to indicate proximity of other trains.
9. Investigate and report on the effects to both signal controls and communication when superimposing centralized traffic control circuits on existing dispatchers or other communication circuits, collaborating with Communications Section, A.A.R.
10. Electronic tubes for use in signal apparatus, recommendation to cover type and designation of tubes to meet various requirements.
11. Investigate and report on the practicability of using frequencies above 30 k.c., for carrier circuits used in centralized traffic control.

* Consulting Member.

The Committee submits for consideration, reports on the following subjects†:

2. Electronic centralized traffic control, Type R, stepping system.
Electronic devices in service.
3. Electronic measuring apparatus applicable to railroad signaling.
4. Various symbols and nomenclature used in electronic systems.
6. Automatic temperature controlled battery charger.
9. Signal carriers used on channel of "C" carrier which operate on underground cable.
10. Electronic tubes for use in signal apparatus.
11. Use of carrier at frequencies above 30 kilocycles for centralized traffic control purposes.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.S.A.—American Standards Association, 70 E. 45th St., New York 17, N. Y.

† Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 17, 1948.

ELECTRONIC CENTRALIZED TRAFFIC CONTROL
TYPE R, STEPPING SYSTEM

In this system all controls transmitted from the control office to a particular field station are transmitted on one particular carrier channel. Likewise, all indications from a field station are transmitted to the control office on another distinctive frequency. Each field station requires one transmitter and one receiver. The control office requires a transmitter and a receiver for each field station. This makes it possible for all stations to transmit indications and receive controls simultaneously.

The control machine in addition to providing means for controlling the field functions, such as switches and signals, also gives the operator information as to the location of trains, direction in which traffic is established in a given block, position of controlled switches, indications displayed by controlled signals, etc.

Each transmitting panel consists of a three-level rotary stepping switch, a stepping pulse generator, a start stick relay, and an electronic frequency generator.

Each receiving panel consists of a rotary stepping switch, a pulse selector, an electronic receiver, a receiver relay, a timing relay, a function selecting relay and one or more final stick relays.

The transmission system is unique, in that all the control (or indication) functions for a given field station are scanned during a single cycle of operation, over one carrier channel.

The stepping switch is of the "spring driven" type, having double ended wipers, which are rotated in one direction only, over a semi-circular bank of contacts. A typical layout provides contacts on stepping switch for as many as 10 two-position functions per station, both for controls and indications. Three levels of contacts are provided with a wiper for each level, fixed on a common shaft. The operation of the switch is such that the stepping magnet must first be energized, then when the circuit is opened the switch will step by means of the spring drive.

To operate a switch to the normal position the operator moves switch control lever to normal position and presses the start button. This energizes the start stick relay and through its front contact closes the circuit to the stepping pulse generator, thereby starting a cycle of stepping. The impulses from the pulse generator are fed into the transmitter, which generates and transmits to the transmission line the proper frequency and level of carrier energy. The time interval or spacing between the transmitted impulses is made long or short to select a function.

This timing action between impulses is produced by the stepping pulse generator, which delays the stepping at the point when the circuit to the generator is closed through the contact of the control lever of the control machine, in series with the contact and wiper of the stepping switch. Should the contact of the control lever be open so there will be no current supplied to terminal of the pulse generator while the wiper engages the contact of the stepping switch then the steps will be of normal time length, the stepping switch magnet being controlled through pulse generator.

At the field station the high selectivity receiver unit detects only its assigned carrier current energy to energize a receiver relay, which in turn actuates a

timing device called a pulse selector. Its function is to permit energization of a timing relay only when a long spacing time occurs between two stepping impulses transmitted from the control office, as occurred when the operator moved the switch control lever to the normal position. When the timing relay becomes energized, the circuit through its front contact will be closed to pick up a function selecting relay. When the receiver relay becomes energized by the next received pulse a circuit will be made from battery to energize the final stick relay. The closing of its front contacts will energize a polarized relay closing the circuit to operate the switch machine to the normal position.

The transmission of indications from the field station to the control office is identical to that described for transmission of controls, except that a start relay is employed to control the pick-up of the start stick relay. The start relay is quick acting and will de-energize on the transfer time of the contacts of the signal type relays when a change in the field takes place. Through the front contact of the start stick relay, the circuit is closed to actuate the stepping pulse generator, thereby starting a cycle of stepping.

The switch repeater relay being energized through the normal position of the switch, current will be fed to a contact of the stepping switch. This causes the final stick relay NWK at the control office to be picked up, through the front contact of which the circuit is made to the indication light.

The carrier frequencies selected for electronic centralized traffic control transmission are generally somewhat higher than those commonly used for carrier telephone communication circuits. In order to select the frequencies which are best suited a study of the territory should be made in advance.

Electronic centralized traffic control is a means of control with communication type circuits. Safety of operation is provided through a medium of field relays similar to other types of centralized traffic control.

Action Recommended

Acceptance as information.

ELECTRONIC DEVICES IN SERVICE

A report on this subject was presented at the 1945 Annual Meeting*. To determine if any further use of electronic devices in connection with railway signal systems had been made, additional information was obtained from a number of railroads using electronic devices. The results are shown in Table I, pages 342 to 344.

Action Recommended

Acceptance as information.

* A.A.R. Signal Section 1944 Proceedings, Vol. XLII, p. 269-A.

TABLE I
ELECTRONIC DEVICES IN SERVICE OR PROPOSED, IN CONNECTION WITH SIGNAL SYSTEMS,
INTERLOCKINGS, CENTRALIZED TRAFFIC CONTROL AND HIGHWAY GRADE CROSSING
PROTECTION AS OF MARCH 1, 1948.

Railroad	Territory (In service or under construction)	Purpose for which used (*Under construction)	Miles of road	No. of loca- tions	Years in service	Changes since installed	Proposed installations
A. T. & S. F.	(a) Voughn—Belen, N. Mex.	Carrier control C.T.C.	116.7	47	3.6	—	—
	(b) Ellinor—El Dorado, Kans.	Carrier control C.T.C.	105.3	15	1.0	—	—
	(c) Canyon—Texico, Texas.	*Carrier control C.T.C.	104.	58	—	—	—
C. B. & Q.	(a) McCook—Oxford, Nebr.	Carrier control C.T.C.	53	—	2.0	None	None
	(b) McCook, Nebr.—E. Derby, Colo.	Carrier control C.T.C.	250	69	1.0	15KC channel changed to 14KC	—
	(c) McCook, Nebr.—Brush, Colo.	Portable carrier telephone	167	—	1.0	None	—
C. & E. I.	(a) N. Alice—Evansville, Ind.	Carrier control C.T.C.	161	40	1.0	—	—
	(b) N. Alice—Evansville, Ind.	Portable carrier telephone	—	—	—	—	—
C. M. St. P. & P.	(a) Miles City, Mont.	Proximity detector	—	1	0.5	Adjustment for moisture and temperature	None
	(b) Ottumwa, Ia.—Laredo, Mo.	Carrier control C.T.C.	156	12	3.0	None	—
	(c) Moberge, S. D.—Marmarth, N. Dak.	Carrier control C.T.C.	190	56	1.0	None	—
C. & N. W.	(a) Chicago—DeKalb, Ill.	*Carrier control C.T.C.	58.7	—	—	—	—
C. & O.	(a) Richmond, Va.—Gladstone, Va.	Carrier control C.T.C.	110.0	—	0.4	None	None
	(b) Covington, Ky.—Parsons, Ohio.	*Carrier control C.T.C.	210	—	—	—	—
Erie	(a) Marion—Polk, Ohio.	Carrier control C.T.C.	78	8	3.1	None	None
	(b) Salamanca—Cuba, N. Y.	Carrier control C.T.C.	60	12	3.1	None	—
I. C.	(a) Baton Rouge, La.	Dimming switch indicator	—	1	1.0	None	None
	(b) Tuscola, Ill.	Light	—	1	4.0	None	—

TABLE I—Continued

Railroad	Territory (In service or under construction)	Purpose for which used (*Under construction)	Miles of road	No. of loca- tions	Years in service	Changes since installed	Proposed installations
M. St. P. & S. S. M.	(a) Burlington, Wis.	Annunciators	—	—	—	Changed from cold to hot cathode	More annunciators
	(b) Duplainville, Wis.	inductively coupled	—	—	—		—
	(c) Franklin Park, Ill.	to line wires, 70-90 KC	—	—	3.0		—
	(d) Superior, Wis.	—	—	—	—		—
N. & W.	(a) Roanoke, Va.—Bristol, Tenn.	Carrier control C.T.C.	107	78	1.6	—	—
	(b) Portsmouth, O.—Clare, Ohio.	Carrier control C.T.C.	94	—	0.5	—	—
N. Y. C. & St. L.	(a) Conneaut, Ohio—Erie, Pa.	Carrier control C.T.C.	66	38	2.2	None	—
	(b) Lima, Ohio—Muncie, Ind.	*Carrier control C.T.C.	82	—	—	—	Proposed
	(c) Ft. Wayne—Argos, Ind.	Carrier control C.T.C.	59	—	—	—	—
N. Y. C.	(a) Harmon to Buffalo, N. Y.	High volt battery charger	—	40	12.0	None	None
	(b) Schenectady, N. Y.	Temperature controlled battery	—	—	0.3	None	—
	(c) Barrytown—Germantown, N. Y.	Power, indication, carrier	—	—	2.7	None	—
	(d) Salina, N. Y.	on power line; remote location—Sig. Sta.	—	—	2.0	None	—
Penna. Sys.	(a) Mifflin—Newport, Pa.	Check locking	—	—	2.0	None	None
	(b) Swissvale, Pa.	Proximity detector	—	—	0.5	Rearranged detector circuit	—
P. T.	(a) Illinois and Kansas	OSing trains	—	4	1.0	None	None
S. A. L.	(a) Savannah, Ga.	Line rectifier on C.T.C.	—	—	0.5	None	None
	(b) Swansea, S. C.	lines	—	—	—	—	—
	(c) Hamlet, N. C.	—	—	—	—	—	—
	(d) Sanford—Hamlet, N. C.	Carrier control C.T.C.	50.4	—	3.5	—	—
	(e) Savannah, Ga.—Hamlet, N. C.	Carrier control C.T.C.	243.7	111	0.3	—	—
	(f) Starke, Fla.—Wildwood, Fla.	Carrier control C.T.C.	63	—	0.3	—	—
S. P.	(a) Ogden—Moor, Utah.	Carrier control C.T.C.	120	39	2.5	None	None
St. L. S. F.	(a) Springfield—Dillon, Mo.	Carrier control C.T.C.	133.0	60	1.3	—	—
	(b) Amory, Miss.—Birmingham, Ala.	Carrier control C.T.C.	124	—	0.2	—	—

TABLE I—Continued

Railroad	Territory (In service or under construction)	Purpose for which used (*Under construction)	Miles of road	No. of loca- tions	Years in service	Changes since installed	Proposed installations
U. P.	(a) Pocatello—Glenns Ferry, Idaho.	Carrier control C.T.C.	160	84	1.3	—	—
	(b) Huntington—La Grande, Oreg.	Carrier control C.T.C.	100	51	0.9	—	—
W. P.	(a) Oakland—Sacramento, Cal.	Unit carrier for outlying indications	—	—	0.5	None	Individual carrier for fire protection devices
	(b) Sacramento—Portola, Cal.	Portable carrier telephone	—	—	1.0	None	
W. M.	(a) Owings Mills, Md.	—	—	—	—	—	Photo cell
	(b) Baltimore, Md.	—	—	—	—	—	Proximity detector
W. & L. E.	(a) West of Kemery—Harmon, Ohio.	Carrier control C.T.C.	7.0	—	0.5	None	None

AUTOMATIC TEMPERATURE CONTROLLED
BATTERY CHARGER

The capacity of a lead storage battery decreases as the temperature of the electrolyte falls and in addition the internal resistance of the cells increases. If the battery is required to deliver a very high current for a few seconds when the battery is very cold, such as starting a dynamotor, the voltage drop may be such that the dynamotor will be slow in starting.

If the dynamotor is used to supply alternating current to a signal power line in the event of a commercial power outage, it is necessary to start the dynamotor and re-energize the line in a matter of one-tenth of a second in order to prevent signal relays from opening.

The battery manufacturers recommend that the voltage of lead cells be increased with a drop in battery temperature: for instance, at 70 degrees F. the cell voltage should be maintained at 2.15 volts and at zero degree F. the voltage should be 2.4 volts.

The increased voltage in cold weather offsets to a large extent the affect of increased internal resistance of the battery.

In order to accomplish this an automatic temperature controlled electronic battery charger system has been developed. This system maintains a fully charged battery in accord with the cell temperature without overcharging the battery. When no load is connected to the battery the charge is just sufficient to compensate for the losses in the cells. When power is restored after an outage in which the battery voltage has dropped more than 3 volts, the rectifier will charge at maximum rate until battery voltage rises to within 2 or 3 volts of final setting and then tapers off.

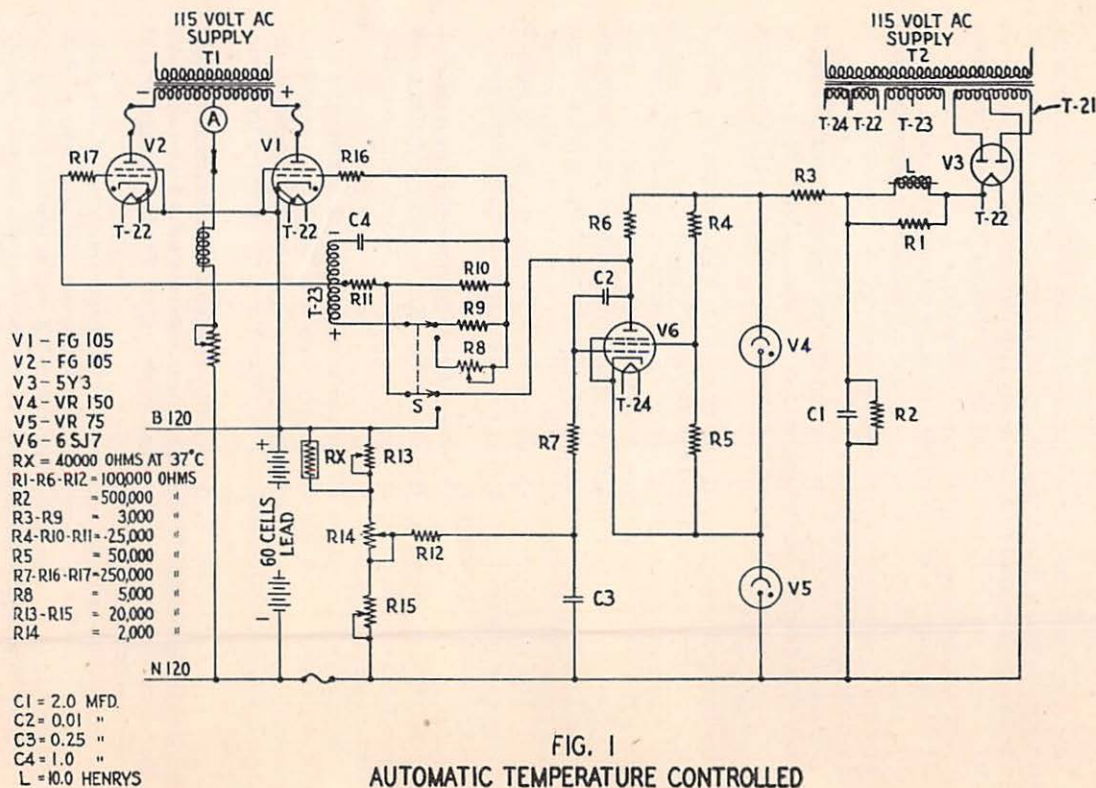
Referring to Fig. 1, the primary of transformer T1 is energized from the commercial 115-volt alternating current supply. The secondary of this transformer furnishes the energy to charge the battery through grid controlled rectifier tubes V1 and V2.

The primary of transformer T2 is also energized from the commercial 115-volt alternating current supply, the secondary T-21 has a mid tap which is connected to negative of the system, the outer taps being connected to the anodes of a small full-wave rectifier V3. The filament is energized by secondary winding T-22 of transformer T2.

The output of rectifier V3 is filtered by reactor L, and condenser C1, and applied, through resistor R3, across regulator tubes V4 and V5 in series, the V5 tube having a drop of approximately 75 volts and the V4 tube having a drop of approximately 150 volts.

A voltage divider is connected across the battery consisting of a negative temperature coefficient resistor RX, potentiometer R14 and resistor R15. Resistor R13 is an adjustable shunt across RX and is used to calibrate the regulator. When R13 is properly adjusted the battery voltage can change with temperature without changing the current in the divider. Resistor RX has a high resistance and varies considerably with temperature change. R14 is adjustable to compensate for the number of cells used in battery.

A decrease in battery voltage will cause a change in current through resistor R15, which in turn will make the grid of the control tube V6 more negative



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with respect to the cathode, the cathode being maintained at 75 volts positive with respect to battery negative by the regulator tube V5. As the negative bias of the control tube V6 increases less current flows through resistor R6 and, therefore, the voltage at the anode increases which in turn reduces the negative grid bias of main rectifier tubes so they will conduct.

Between the grids of the two main rectifier tubes is connected a phase shift circuit which causes the alternating current bias applied to grids of V1 and V2 to lag the anode voltage by approximately 90 degrees.

As the voltage of the battery rises the grid voltage of the control tube becomes more positive, thereby causing a greater drop across resistor R6. This increases the negative bias on the grids of V1 and V2, reducing the charging current. Finally the anode voltage of the control tube settles to a point where the charging rate just equals the steady battery load and losses.

Resistors R4 and R5 are provided to maintain proper screen voltage on control tube. Resistor R12 and condenser C3 are used as a filter to remove ripple voltage caused by charging current. Resistor R7 and condenser C2 are used as an anti-hunt filter. Resistor R2 is used as a bleeder across condenser C1.

Using a commercial size reactor it was found advisable to add resistor R1 in order to avoid the possibility of oscillations.

The values shown for resistors and condensers are approximate and may vary in different units.

The potentiometer R8 and switch S are provided so that the charging of batteries may be controlled manually in the event it is desired to give the battery an equalizing charge. This is accomplished by removing the automatic direct current bias from V1 and V2, and controlling the phase shift of the alternating current bias by adjusting R8. The control tubes with associated parts are mounted on a chassis with a perforated metal enclosing cover approximately 6 by 7 by 14 inches.

A unit of this type has been in service for several months under extreme changes in battery temperature and has given excellent results.

Action Recommended

Acceptance as information.

SIGNAL CARRIERS USED ON CHANNEL OF "C" CARRIER
WHICH OPERATE ON UNDERGROUND CABLE

The Seaboard Air Line R. R. has placed an automatic signal system in service with controlled signals and power-operated switches at each end of all sidings between Hamlet, N. C. and Savannah, Ga., via Columbia, S. C., a distance of approximately 248 miles. The power-operated switches and controlled signals are controlled by the dispatcher at Savannah, Ga., utilizing conventional two-wire code equipment. However, an underground cable is utilized for the transmission circuit connecting the control machine at Savannah with the field stations, which are located between Savannah, Ga., and Hamlet, N. C. This underground cable consists of two No. 10 A.W.G. solid copper wires, each of which are circumscribed by a $\frac{3}{64}$ inch Polyethylene insulation. The two Polyethylene insulated conductors are twisted and a $\frac{1}{4}$ inch Flamenol jacket covers the twisted pair. It was placed directly into the ground without a conduit covering and was placed by use of cable plow to a depth of approximately 18 inches below the surface of the ground. The cable plow was pulled by a cable attached to an "I" beam fastened to a flat car which was pushed by a locomotive.

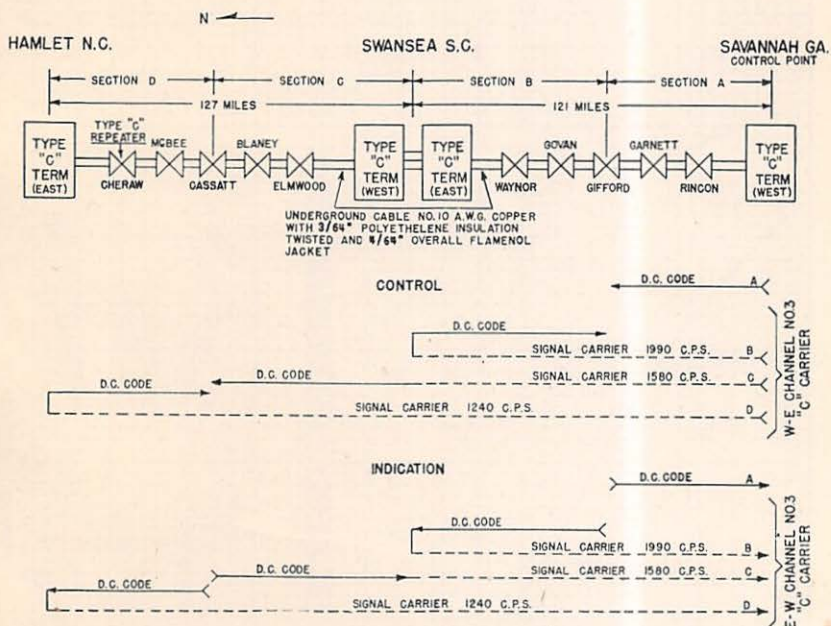
It will be noted from Fig. 1 that the underground cable is divided into four sections: namely, Sections A, B, C and D, to provide four separate direct current control circuits, each of which are approximately 62 miles in length. This arrangement was chosen since a maximum of 35 stations is practicable on the coded signal system utilized for the installation and not more than this number of stations was needed within a distance of 62 miles.

In order to operate Sections B, C and D, shown in Fig. 1, without providing additional conductors, Type "C" carrier terminals were installed at Savannah, Ga., Swansea, S. C. and Hamlet, N. C. At Swansea, S. C., two Type "C" terminals were provided. It will be noted that five "C" carrier repeaters were utilized between each of the "C" carrier terminals connected by an underground cable. This arrangement was necessary because the electrical losses of the cable between the "C" carrier terminals were of such magnitude as to require amplification of the carrier currents.

From the typical graph, Fig. 2, it will be noted that the cable losses per mile are approximately 1 decibel at 17 kilocycles and 1.34 decibels at 30 kilocycles.

It will be noted from Fig. 1 that three carriers are utilized to control the direct current code Sections B, C and D. Two carrier frequencies of 1990 CPS and 1580 CPS are transmitted from Savannah to Swansea over the W-E channel No. 3 of the "C" carrier in order to control the direct current code Sections B and C, respectively. The other carrier frequency of 1240 CPS is transmitted over the same channel of the "C" carrier from Savannah to Hamlet in order to control the direct current code Section D. If it is desired to expand the system, it is possible at present to operate at least 12 signal carriers per direction over a "C" carrier channel. The indication codes are transmitted in a similar manner except over the E-W channel No. 3 of the "C" carrier.

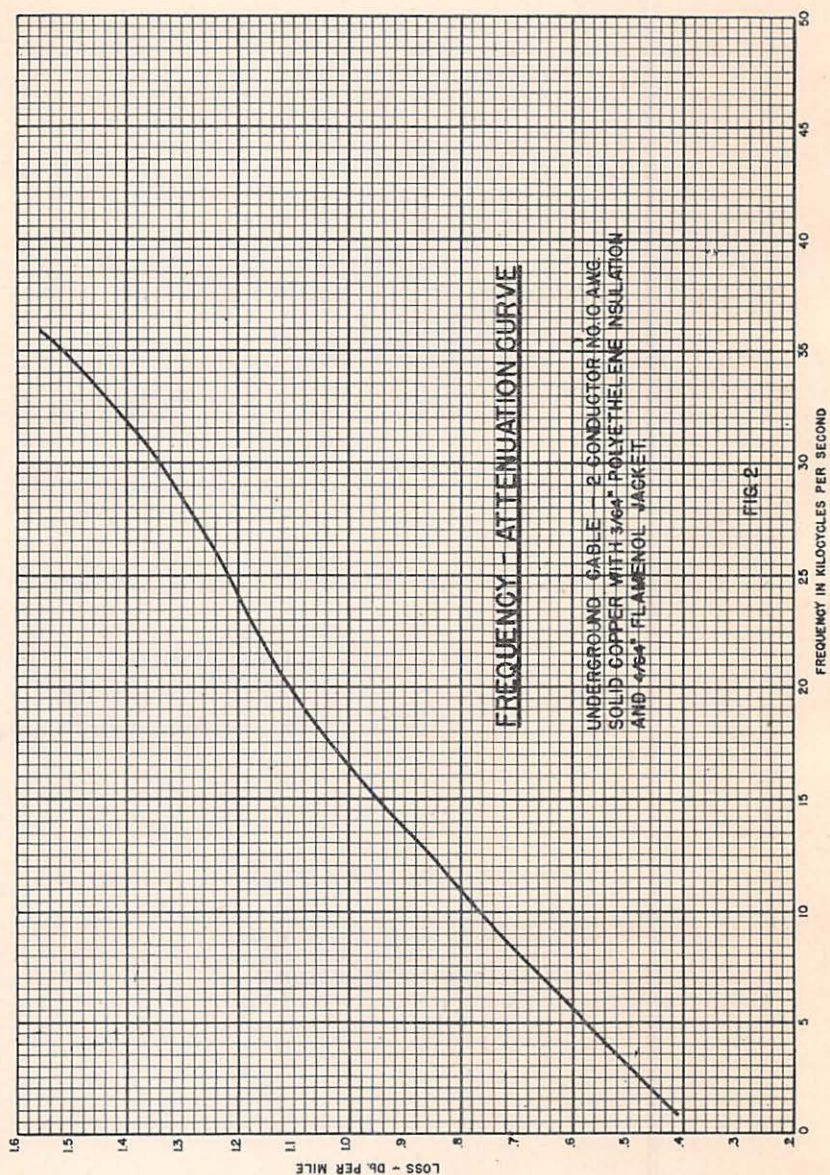
Very good transmission qualities are obtained from the system for the carrier frequencies and a very stable circuit was obtained since the "C" system con-



SCHEMATIC CODE LINE LAYOUT

AUTOMATIC SIGNAL INSTALLATION EMPLOYING
VOICE FREQUENCY SIGNAL CARRIER AND TYPE
"C" COMMUNICATION CARRIER SYSTEMS.

Fig. 1.



tains an automatic volume control feature. It should be noted that only the third channel of the "C" carrier was utilized and since this system provides three duplex voice frequency channels, the two spare channels can be used for communication purposes.

The above signal system utilizes coded track circuits in order to eliminate line wires and since the code wires are underground the signal system should operate successfully under varying weather conditions. Provision has been made in the event of code cable failure to effect automatic transfer of the signal carriers to operate over a Type "H" carrier utilizing an existing telephone open wire circuit.

Action Recommended

Acceptance as information.

ELECTRONIC TUBES FOR USE IN SIGNAL APPARATUS*

The following is a partial list of various electronic tubes now being used in signal apparatus. For complete information on tube characteristics, see Manufacturers Data Books on Tubes.

Type	Name	Cathode		Plates		Base	Pins
		V.	A.	Max. V.	Max. dissipation		
0A4-G	Cold Cathode Control Tube	See	Mfgs.	Data		Octal	
5U4-G	Full-Wave High Vacuum Rectifier	5.0	3.0	550	220 Ma.	Octal	5
5V4-G	Full-Wave High Vacuum Rectifier	5.0	2.0	500	175 Ma.	Octal	5
5Y3-G	Full-Wave High Vacuum Rectifier	5.0	2.0	500	125 Ma.	Octal	5
5Y3-GT	Full-Wave High Vacuum Rectifier	5.0	2.0	500	125 Ma.	Octal	5
6C6	Triple-Grid Detector Amplifier	6.3	0.3	300	2.5 W.	Small	6
6C8-G	Twin Triode Amplifier	6.3	0.3	200	3.2 Ma.	Octal	8
6F5-G	High MU Triode Class A Amplifier	6.3	0.3	100 250	.4 Ma. .9 Ma.	Octal Octal	5 5
6F8-G	Twin Triode Amplifier	6.3	0.6	250	9 Ma.	Octal	8
6H6	Twin Diode	6.3	0.3	100	8 Ma.	Octal	7
6J5	Detector Amplifier Triode	6.3	0.3	300	2.5 W.	Octal	6
6N7-G	Twin Triode Class B Amplifier	6.3	0.8	300	1.25 Ma.	Octal	8
6SJ7	Triple Grid Detector Amplifier	6.3	0.3	300	2.5 W.	Octal	8
6SK7	Triple Grid Super-Control Amplifier	6.3	0.3	300	4. W.	Octal	8
6SK7-GT	Triple Grid Super-Control Amplifier	6.3	0.3	300	4. W.	Octal	8
6SL7-GT	Twin Triode Amplifier	6.3	0.3	250	1 W.	Octal	8
6SN7-GT	Twin Triode Amplifier	6.3	0.6	250	1 W.	Octal	8
6SQ7	Duplex Diode High MU Triode	6.3	0.3	300	0.9 Ma.	Octal	8
6V6	Beam Power Amplifier	6.3	0.45	315	34 Ma.	Octal	7
6V6-GT	Beam Power Amplifier	6.3	0.45	313	34 Ma.	Octal	7
7C7	Triple Grid Detector Amplifier	7.0	0.16	300	1 W.	Lock-in	8

* Previous report on this subject appears in A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, pp. 259 and 395.

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Type	Name	Cathode		Plates		Base	Pins
		V.	A.	Max V.	Max. dissipation		
26A6	R-F Amplifier Pentode	26.5	0.07	26.5 250	1.7 Ma. 10.5 Ma.	Octal	7
26A7-GT	Twin Pentode Power Amplifier	26.5	0.6	26.5 50	20 Ma. 2 W.	Octal	8
28D7	Double Beam Power Amplifier	28	0.4	100	3 W.	Lock-in	8
35L6-GT	Beam Power Amplifier	35	0.15	200	8.5 W.	Octal	7
42	Power Amplifier Pentode	6.3	0.7	375	11 W.	Medium	6
809	Transmitting Triode	6.3	2.5	1000	30 W.	Medium Ceramic	4
811	Transmitting Triode	6.3	4.0	1500	55 W.	Medium Ceramic	4
884	Thyratron	6.3	0.3	350	75 Ma.	Medium	6
2050	Thyratron	6.3	0.6	1300	100 Ma.	Octal	8
GL421	Beam Power Tetrode	30	0.4	50		Medium Bayonet	
PJ-2	Plotron	4.5	1.1	350			4
PJ-4	Plotron	4.5	1.1	350			4
FG-95	Thyratron	5.0	4.5	1000	15 A	Medium Bayonet	4
FG-105	Thyratron	5.0	10.0	2500	40 A	Super Jumbo	4
FG-271	Ignitron	—	—	500	56 A	—	—
866A	Plotron	2.5	5.0	10000	—	Medium Bayonet	

Due to the many changes in tubes no definite recommendations can be made at this time.

In connection with new tubes the tube manufacturers have recently developed a new line of special tubes where long life, rigid construction, uniformity and stability are needed. These tubes are specially designed, precisely manufactured, exactly processed, and rigorously tested for use in industrial equipment requiring tube features of at least 10,000 hours life, exceptional uniformity and stability of characteristics, and rigidity to resist shock and vibration.

The *long life* built into the special tubes is the result of (1) designing the cathode to operate at a relatively low temperature; (2) maintaining exacting control during processing to prevent deposit of cathode materials on other electrodes; (3) using pure tungsten heaters provided with sleeves to give long heater life with frequent "on-off" switching; (4) inspecting each assembly with extreme detail; and (5) rating the tubes conservatively.

Uniformity and stability of characteristics have been achieved both initially and during life by precision designs and extreme care in manufacturing methods. The designs incorporate many unique structural features contributing

to uniformity. Not only are the structures extremely rigid, but the parts are precisely made and accurately fitted to eliminate variations due to mechanical movement. In addition, parts are locked in place by means of wedged plate ears, welded eyelets for side rods, stops on grid rods, and embossed and pinched cathodes.

The *rigidity* of the special tubes is such that they will withstand 2.5g of continuous vibration at a frequency of approximately 20 cycles per second for hundreds of hours at maximum rated voltages. Structural features make these tubes capable of withstanding impact shocks of 100g for extended periods and 500g for short periods with maximum rated voltages.

Action Recommended

Acceptance as information.

USE OF CARRIER AT FREQUENCIES ABOVE 30 KILOCYCLES FOR CENTRALIZED TRAFFIC CONTROL PURPOSES

The St. Louis-San Francisco Railway has in operation a centralized traffic control installation using high frequency carrier which extends from Springfield to Dillon, Mo., a distance of 133 miles, with the control machine at Springfield. The first section extends 56 miles to Lebanon and is a direct current circuit connected directly to the machine at Springfield.

The second C.T.C. section, 62 miles from Lebanon to Newburg, is controlled and indicated by carrier currents superimposed on the code line. A frequency of 56.4 kilocycles is used for controls Springfield to Lebanon, and 44.1 kilocycles for indications Lebanon to Springfield.

A third C.T.C. section extends 15 miles from Newburg to Dillon and is controlled and indicated by carrier currents also superimposed on the code line. A frequency of 51.1 kilocycles is used for controls Springfield to Newburg and 40.0 kilocycles for indications Newburg to Springfield. The third section is laid out so that centralized traffic control can be extended 55 miles to Pacific.

A new code line was built using No. 8, 40 per cent copper-clad wire. The code line is equipped with filters and telephones can be used throughout. The code line is cut into telephone booths installed as part of the C.T.C. system. Telephones can be transferred to the code line by a switch and thus used as an additional circuit for communication with the office.

The choice of frequencies above 30 kilocycles for this installation was dictated by local conditions. Paralleling circuits use a number of carriers of a type which might have caused mutual interference at lower frequencies.

The use of higher frequencies introduced some trouble from keying transients. It was found necessary to modify the keying system so as to reduce keying transient.

To guard against the effect of adverse weather conditions, stand-by carrier repeaters are installed at Marshfield, about half way between Springfield and Lebanon, and at Crocker, half way between Lebanon and Newburg.

It has been the experience that attenuation on railroad lines is always somewhat higher than indicated by published data. This was true on the Spring-

field-Dillon line. Some of the additional attenuation was traced to the fact that the capacity of some of the phone drops resonated with blocking filters used to prevent phones from shorting the line at carrier frequencies. This condition was remedied by detuning the filters. Other loss was traced to absorption by paralleling signal wires which is probably always present to some extent, but small at lower frequencies.

Action Recommended

Acceptance as information.

ELECTRONIC MEASURING APPARATUS APPLICABLE
TO RAILROAD SIGNALING*

As information only, the Committee submits a partial list of electronic measuring apparatus applicable to railroad signaling. See Table I, pages 356-361. In no case is any kind of recommendation made. The list includes the following:

1. Electronic voltmeters.
2. Test sets.
3. Component and circuit testers.

Action Recommended

Acceptance as information.

* Previous report on this subject appears in the 1947 Annual Meeting Advance Notice (A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, p. 302-A.)

TABLE I

Manufacturer	Model No.	Range in volts	Accuracy, per cent	Frequency range	Size	Weight
ELECTRONIC VOLTMETERS						
Alfred W. Barber Labs.	Voltmeter 31	100; 300; 1,000; 3,000; 10,000	5	100 KC—100 MC	$5\frac{1}{2} \times 9\frac{1}{2} \times 9\frac{1}{2}$	8 lbs.
Alfred W. Barber Labs.	Voltmeter VM-27A	1; 3; 10; 30; 100	2	20 CY to over 100 MC	8 x 8 x 8	11 lbs.
Alfred W. Barber Labs.	Voltmeter 32	3; 10; 30; 100; 300	5	500 KC—500 MC	$5\frac{1}{2} \times 9\frac{1}{2} \times 9\frac{1}{2}$	8 lbs.
Alfred W. Barber Labs.	Voltmeter VM-27-ZC				8 x 8 x 8	11 lbs.
Chicago Industrial Instrument Co.	Volt-Ohm- Milliammeter 458	DC—5; 10; 50; 100; 500; 2,000 AC—12.5; 25; 125; 250; 1,250 MA-DC—1; 10; 100 MA-AC—2.5; 25; 250			$10\frac{1}{4} \times 6\frac{3}{4} \times 5\frac{1}{2}$	8 lbs.
Electronic Mfg. Co.	Voltmeter Ohmmeter 100	DC—3; 30; 150; 300; 600 (Up to 2,400 with probe) AC—3; 30; 150; 300			10 x 10 x 7	
Hickok	Volt-Ampere Wattmeter 900	AC volts—0; 130; 260 AC watts—0; 20; 100; 500; 1,000; 2,000 AC amp.—0; 1.3; 6.5; 13; 26			$9\frac{1}{2} \times 6\frac{1}{4} \times 3$	8½ lbs.
Jackson	Vacuum Tube Voltmeter 645	AC—0; 1; 4; 10; 40; 100; 400; 1,000 DC—0; 4; 10; 40; 100; 400; 1,000		50 cycles to 200,000 cycles		
Precision	Multi-Range Tester 832-A	DC—0; 6; 30; 150; 300; 600; 1,200 AC—0; 12; 60; 300; 600; 1,200; 2,400			7 x $4\frac{1}{2}$ x 3	
R. C. A.	Volt ohmmyst 195-A	AC and DC—up to 1,000 ohms		20—100,000 cycles		
Simpson	Vacuum Tube Voltmeter 266	AC and DC—0; 5; 10; 50; 100; 250; 500; 1,000; 5,000			$8\frac{1}{2} \times 9\frac{1}{2} \times 8$	8 lbs.

TABLE I—Continued

Manufacturer	Model No.	Range in volts	Accuracy, per cent	Frequency range	Size	Weight
Triplet	Volt-Ohm Milliammeter 2450	AC and DC—0; 2.5; 10; 50; 250; 500; 1,000			10 x 10 x 5 $\frac{3}{4}$	
Hewlett-Packard Co.	Vacuum Tube Voltmeter 400A	AC—0.03; 0.1; 0.3; 1; 3; 10; 30; 100; 300	3	10 CPS—1 MC	7 $\frac{1}{2}$ x 8 x 9	15 lbs.
Hewlett-Packard Co.	High Freq. Vacuum Tube Voltmeter 410A	AC—1-300 v. DC—1-1,000 v. 0.02 ohm—500 meg.		20 CPS to 700 MC		
TEST SETS						
Sylvania	Multi-Purpose 134	AC—3; 10; 30; 100; 300 DC—10; 30; 100; 300; 1,000	± 3	20 CPS to 300 MC		
Chicago Industrial Instrument Co.	Volt-Ohm Milliammeter (Miniature Model) 450-A	DC—5; 10; 50; 500; 1,000			3 $\frac{15}{16}$ x 2 $\frac{7}{8}$ x 2	12 oz.
Chicago Industrial Instrument Co.	Volt-Ohm Milliammeter 451B	AC and DC—10; 50; 100; 500; 1,000			3 $\frac{15}{16}$ x 2 $\frac{7}{8}$ x 2	12 oz.
Chicago Industrial Instrument Co.	Volt-Ohm Milliammeter 312	AC and DC—25; 50; 125; 250			3 $\frac{15}{16}$ x 2 $\frac{7}{8}$ x 2	12 oz.
Chicago Industrial Instrument Co.	Volt-Ohm Milliammeter 431	DC—0; 30; 300; 1,500; 2,000 ohm per volt AC—15; 150; 1,000 ohm per volt			5 $\frac{5}{16}$ x 2 $\frac{15}{16}$ x 2 $\frac{1}{2}$	3 lbs.
Chicago Industrial Instrument Co.	Volt-Ohm Milliammeter 421	DC and AC—7.5; 15; 150; 750; 1,500			5 $\frac{7}{16}$ x 3 $\frac{3}{16}$ x 3	3 lbs.
Electronic Measurements Corp.	Volt-Ohm Milliammeter 101	DC—0; 6; 60; 300; 600; 3,000 AC—0; 12; 120; 600; 1,200	2	25 CY—1 MC	5 $\frac{3}{4}$ x 8 $\frac{5}{8}$ x 2 $\frac{3}{4}$ (Portable Case) 7 $\frac{1}{2}$ x 8 $\frac{5}{8}$ x 3 $\frac{3}{4}$ (Complete with test leads)	

TABLE I—Continued

Manufacturer	Model No.	Range in volts	Accuracy, per cent	Frequency range	Size	Weight
Electronic Measurements Corp.	Volt-Ohm Milliammeter 100	AC and DC—0; 3; 12; 60; 300; 1,200; 6,000		25 CY—1 MC	$6\frac{1}{4} \times 3\frac{1}{2} \times 3$	
Freed Transformer Co., Inc.	Megohmmeter 1020	1 megohm 1,000,000 meg.			$9\frac{1}{2} \times 10\frac{1}{2} \times 8$ (Portable)	21 lbs.
Hickok	Volt-Ohm Capacity Milliammeter 203	AC and DC—0; 3; 12; 30; 120; 300; 1,200		Up to 5 MC	$9 \times 11\frac{1}{2} \times 7$	13 lbs.
Hickok	Volt-Ohm Capacity Milliammeter 209	AC and DC—3; 12; 30; 120; 300; 1,200		Up to 5 MC	$14 \times 16\frac{1}{2} \times 8$	18 lbs.
Hickok	Volt-Ohm Milliammeter 435	DC and AC—0; 2.5; 10; 50; 250; 1,000; 5,000			$6 \times 8\frac{1}{4} \times 4$	5 lbs.
Jackson	Vacuum Tube Voltmeter 642	AC and DC—0; 10; 100; 250; 500; 1,000; 5,000			$8\frac{1}{2} \times 8\frac{1}{2} \times 6$	6 lbs.
Simpson	Set Tester 260				$5\frac{1}{2} \times 7 \times 3$	$3\frac{1}{4}$ lbs.
Simpson	Micro Testers 390	AC only—0-150; 300			$3 \times 5\frac{1}{8} \times 2\frac{1}{2}$	$2\frac{1}{4}$ lbs.
Simpson	Volt-Ohm Milliammeter 240	AC—15; 150; 750; 3,000 DC—15; 75; 300; 750; 3,000				
Triplett	Volt-Ohm Milliammeter	AC and DC—0; 10; 50; 250; 500; 1,000			$10 \times 10 \times 5\frac{3}{4}$	
Triplett	Volt-Ohm Milliammeter 625-N	DC—0; 1.25; 5; 25; 125; 500; 2,500 at 20,000 ohms per volt; 0; 2.5; 10; 50; 250; 1,000; 5,000 to 10,000 ohms per volt. AC—0; 2.5; 10; 50; 250; 1,000; 5,000 at 10,000 ohms per volt				

TABLE I—Continued

Manufacturer	Model No.	Range in volts	Accuracy, per cent	Frequency range	Size	Weight
Weston	Volt-Ohmmeter 564 Type 3-C	DC—3; 30; 300; 600	2		$5\frac{1}{2} \times 3\frac{3}{4} \times 2\frac{5}{16}$	$1\frac{3}{4}$ lbs.
Weston	Power Level Meter, Volt- meter, Output Meter 695 Type 11	7 voltage ranges from 2-200 volts	5		$5\frac{1}{2} \times 3\frac{3}{4} \times 3\frac{1}{2}$	$1\frac{1}{2}$ lbs.
Weston	Volt-Ohm Milliammeter 697	AC and DC—7.5; 15; 150; 750	DC—2% AC—5%		$5\frac{3}{16} \times 3\frac{3}{4} \times 3\frac{3}{16}$	$1\frac{3}{4}$ lbs.
Weston	Super Sensitive Analyzer 779 Type 1	AC and DC—2.5; 10; 50; 250; 1,000	AC—3%		$6\frac{5}{8} \times 9\frac{1}{8} \times 4\frac{7}{8}$	6 lbs.
Weston	Industrial Circuit Tester 785	DC—1; 10; 50; 200; 500; 1,000 AC—5; 15; 30; 150; 300; 750	DC—2% up to 1,000 volts 3% on 1,000 volt range		$13 \times 12\frac{1}{2} \times 5\frac{1}{2}$	$13\frac{1}{2}$ lbs.
General Electric	Unimeter Type VM-3	DC and AC— $2\frac{1}{2}$; 10; 50; 250; 1,000; 2,500			$9 \times 10 \times 4\frac{5}{8}$	$9\frac{3}{4}$ lbs.
General Electric	Unimeter Type YMW-1	AC and DC—0; 2.5; 10; 50; 250; 1,000			$12\frac{3}{8} \times 9\frac{3}{4} \times 5\frac{1}{2}$	12 lbs.
COMPONENT AND CIRCUIT TESTERS						
Sylvania	Counter Tube Tester				$5\frac{5}{8} \times 14\frac{3}{16} \times 14\frac{3}{4}$	17 lbs.
Sylvania	Oscilloscope Type 131	10 CY—100 KC			$10\frac{3}{4} \times 9\frac{1}{8} \times 13\frac{3}{4}$	
DuMont	Oscillograph 274			20 cycles—50 KC	$14 \times 8\frac{5}{8} \times 19\frac{5}{8}$	35 lbs.
DuMont	Oscillograph 241			5 cycles—100 KC	$17\frac{1}{2} \times 20\frac{3}{4} \times 21$	65 lbs.

TABLE I—Continued

Manufacturer	Model No.	Range in volts	Accuracy, per cent	Frequency range	Size	Weight
DuMont	Oscillograph 208B				$15\frac{3}{4} \times 8\frac{7}{8} \times 20\frac{1}{4}$	54 lbs.
DuMont	Oscillograph 224-A			10C—100 KC	$14\frac{1}{8} \times 8\frac{3}{8} \times 15\frac{1}{8}$	49 lbs.
Hickok	Tube Tester 532P (Portable) 532C (Counter)				$17 \times 18 \times 8\frac{1}{2}$	27 lbs.
Hickok	Oscillograph 505			30 C—1 MC	$14 \times 11\frac{1}{2} \times 15\frac{1}{2}$	32 lbs.
Hickok	Oscillograph 195			10 CY—50 KC	$8\frac{3}{16} \times 18\frac{1}{2} \times 13$	25 lbs.
Hickok	Tube and Set Tester 534	AC and DC—20; 200; 500; 1,000; 5,000			$17 \times 18 \times 8\frac{1}{2}$	28 lbs.
Jackson	Counter Tester 636-C				$14 \times 12 \times 5\frac{1}{2}$	11 lbs.
Jackson	637 Tube Tester	AC and DC—10; 100; 250; 500; 1,000; 2,500			$14\frac{3}{4} \times 13\frac{3}{4} \times 6$	
Precision	Series 920 (Set, Tube and Battery Tester)				Various	Various
Precision	Series 834 Circuit Tester	AC and DC—12; 60; 300; 600; 1,200; 6,000			$7 \times 4\frac{1}{2} \times 3$	
Radio Corp. of America	155-C Oscilloscope			10 CPS—60 KC		
Simpson	330 Tube Tester				$15\frac{1}{2} \times 9\frac{1}{2} \times 6\frac{3}{4}$	9 lbs.

TABLE I—Continued

Manufacturer	Model No.	Range in volts	Accuracy, per cent	Frequency range	Size	Weight
Triplet	2425 Tube Tester				10 x 10 x 5 $\frac{3}{4}$	
Weston	798—Type 3 Tube checker				17 $\frac{3}{4}$ x 11 $\frac{1}{2}$ x 6 $\frac{1}{4}$	23 lbs.
General Electric	TC—3A Tube Checker	DC—10; 100; 1,000			14 x 14 x 17 $\frac{3}{4}$	13 lbs.
General Electric	Oscilloscope CRO-3A				8 x 12 $\frac{1}{2}$ x 13	25 lbs.
General Electric	Oscilloscope CRO-5A				14 x 8 x 19	40 lbs.
Hewlett-Packard	Oscilloscope 200					

VARIOUS SYMBOLS AND NOMENCLATURE USED IN
ELECTRONIC SYSTEMS**Symbols.*

For standard symbols to be used in electronic circuit plans, the Committee recommends American Standards Z32.15-1944 and Z32.10-1947, issued by the American Standards Association, be followed.

Nomenclature.

The Committee recommends American Standard C42-1941, Group 70, issued by the American Standards Association, be referred to for electronic nomenclature.

Action Recommended

Acceptance as information.

*Previous report on this subject appears in A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, p. 302-A.

COMMITTEE XII—CIRCUIT DESIGN

Personnel

W. Welsh, Chairman	
H. A. Scott, Jr., Vice-Chairman	
E. W. Anderson	E. W. Horning
B. E. Brooksby	J. P. Kaysen
T. L. Carlson	J. H. Molloy
W. H. Claus	E. Pitt
B. R. Dellinger	D. H. Steiner
A. L. Essman	R. E. Testerman
O. C. French	W. M. Whitehurst
H. A. Haines	F. Youngwerth
H. L. Hinton	A. Langdon*
H. A. Thompson*	

Signal Section, A.A.R. :

The following outline of work has been assigned:

1. Indexing signal literature.
2. Prepare typical circuits representing current practice for railway signaling, as follows:

- (a) Automatic block signals.

1. For track equipped for operation in one direction only.
 - (a) Color light type signals, conventional d.c. track circuits.
 - (b) Searchlight type signals, conventional d.c. track circuits.
 - (c) Coded track circuits with and without use of line wires.
 - (d) Protection for switches and crossovers, coded and non-coded territory.
 - (e) Electric switch locking.
 - (f) Spring switch protection.
 - (g) Approach and advance lighting.
 - (h) Light out protection.
2. For track equipped for operation in both directions.
 - (a) Color light type signals, conventional d.c. track circuits.
 - (b) Searchlight type signals, conventional d.c. track circuits.
 - (c) Protection for switches and crossovers, coded and non-coded territory.
 - (d) Coded track circuits.
 - (e) Electric switch locking.
 - (f) Spring switch protection.
 - (g) Approach and advance lighting.
 - (h) Light out protection.

* Consulting Member.

- (b) Interlocking.
 - 1. Conventional and relay type interlocking, unit and route types.
 - (a) Route-check network (lever-agreement relays).
 - (b) Signal control network.
 - 1. Color light type signals.
 - 2. Searchlight type signals.
 - (c) Signal indication.
 - (d) Time locking.
 - (e) Approach locking.
 - (f) Route locking.
 - (g) Switch locking.
 - (h) Switch control.
 - (i) Switch indication.
 - (j) Power distribution.
 - (k) Model board indications.
 - (l) Remote control circuits.
 - (m) Automatic interlocking.
 - (n) Electric locking of hand-operated switches within interlocking limits.
 - (o) Traffic locking.
 - (p) Drawbridge protection.
 - (c) Highway crossing signal protection.
 - 1. Control arrangement.
 - (a) Interlocking relays.
 - (b) Directional stick relays.
 - (c) Manual or auto-manual control features.
 - (d) Time-element cut-outs.
 - (e) Switch-reverse cut-outs.
 - (f) Selective speed controls.
 - (g) Interconnection with street traffic signal devices.
 - 2. Types of protection.
 - (a) Flashing lights.
 - (b) Automatic and semi-automatic gates.
 - (c) Wig-wags and bells.
 - (d) Wayside typical circuits for train stop, train control, and cab signals.
 - 1. Continuous.
 - 2. Intermittent.
 - (e) Miscellaneous.
 - 1. Dragging equipment detectors.
 - 2. High water detectors.
 - 3. Fire and alignment detectors.
 - 4. Rock and mud slide fences.
 - 5. Yard track indicators.
 - 6. OSing devices.
 - 7. Power and color light train order signals.

The Committee submits for consideration, reports on the following subjects*:

2. A.A.R. Sig. Sec. 8012A-8016A, 8018A-8024A, 8026A-8029A and 8032A.

TYPICAL CIRCUITS REPRESENTING CURRENT PRACTICE FOR RAILWAY SIGNALING†

The Committee submits 25 typical plans illustrating many of the principles that underlie current circuit practice in the installation of conventional power interlockings, automatic interlocking, traffic locking, electric switch locks, spring switches, APB automatic signals, coded track circuits, earth and rock slide detectors, dragging equipment detectors and yard track indicators.

In making use of these typicals, it is expected that the designer will take due note of the conditions at the particular locations involved as well as the choice of equipment to be used, and vary his working plans accordingly.

The Committee presents the following:

A.A.R. SIG. SEC.

- 8012A—Typical circuits for breakable type dragging equipment detector with illuminated sign on approach signal. (Assignment 2-e-1)
- 8013A—Same without sign on approach signal. (Assignment 2-e-1)
- 8014A—Typical circuits for spring switch at end of siding, track signaled in one direction, with normally clear signals and with approach locking. (Assignment 2-a-1-f)
- 8015A—Same except with manual clearing of siding signal by train crew. (Assignment 2-a-1-f)
- 8016A—Typical circuits for falling rock and earth slide detector. (Assignment 2-e-4)
- 8018A—Typical circuits for lever control of electric switch lock within interlocking limits. (Assignment 2-b-1-n)
- 8019A—Typical electric switch lock circuits with time locking with and without automatic releasing section. (Assignment 2-a-1-e)
- 8020A—Typical circuits for yard track indicator, direct wire control. (Assignment 2-e-5)
- 8021A—Same except code control. (Assignment 2-e-5)
- 8022A—(Four sheets)—Typical circuits for electric interlocking with mechanical locking and dynamic switch indication. (Assignments 2-b-1-b, c, d, e, f, g, h, i, k)
- 8023A—(Four sheets)—Typical circuits for power interlocking with mechanical locking using battery switch indication, electric or electro-pneumatic switch movements and searchlight signals. (Assignments 2-b-1-b, c, d, e, f, g, h, i, k)

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 17, 1948.

† Previous report on this subject appears in A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, pp. 308-A and 431-A.

- 8024A—(Two sheets, two schemes)—Typical coded track circuits without line wires using direct code for 3 aspect automatic signals, and reverse code for full block approach lighting and other approach controls. (Assignment 2-a-1-c)
- 8026A—Typical relay type traffic circuits between attended offices. (Assignment 2-b-1-o)
- 8027A—(Sheet 1 of a series to follow)—Typical 3 aspect color light automatic signal circuits, tracks signaled in both directions using 3 wire HD control. (Assignment 2-a-2-a)
- 8028A—(Two sheets)—Typical circuits for automatic interlocking. (Assignment 2-b-1-m)
- 8029A—(Sheet 1 of a series to follow)—Typical 4 aspect color light automatic signal circuits, track signaled in both directions using 4 wire HD control. (Assignment 2-a-2-a)
- 8032A—Typical circuits for self restoring type dragging equipment detector with illuminated sign on approach signal. (Assignment 2-e-1)

Action Recommended

Acceptance as information.

RULES OF ORDER

Effective April 6, 1938

Revised: December 6, 1938; May 22, 1940; March 12, 1941;

May 17, 1944; December 11, 1946.

1. **REPRESENTATIVES:** The representatives of Member Roads in the Signal Section shall be employees engaged in an official or supervisory capacity in the design, construction or maintenance of railroad signaling devices. Included within this category shall be Signal Superintendents, Signal Engineers and their Assistants, Signal Inspectors, Chief Draftsmen, Signal Supervisors and Assistant Signal Supervisors, or others with corresponding duties.
2. **AFFILIATED MEMBERS:**
 - (a) **RAILROAD AFFILIATED MEMBERS:** A member of a State or Federal regulatory body, or a railroad employee not embraced within the provisions of paragraph 1 (including those temporarily relieved from service or furloughed) may become a **RAILROAD AFFILIATED MEMBER** upon approval of his application by the Committee of Direction. Such a member will pay an annual fee of \$3.00 (which may be changed from year to year at the discretion of the Committee of Direction), on January 1st of each year, for which he will receive currently the Advance Notices and Minutes of the Section.
 - (b) **AFFILIATED MEMBERS:** A representative of an organization or an individual engaged in the design, manufacture, sale or construction of signal devices or materials applicable thereto, or one who is qualified by his business relations and practical experience to cooperate with the Section, may become an **AFFILIATED MEMBER** thereof upon approval of his application by the Committee of Direction. An Affiliated Member will pay an annual fee of \$6.00 (which may be changed from year to year at the discretion of the Committee of Direction), on January 1st of each year, for which he will receive currently the Advance Notices and Minutes of the Section.
 - (c) A Railroad Affiliated or an Affiliated Member shall have the rights and privileges accorded a Member Road representative except voting or the holding of office.
 - (d) A Railroad Affiliated or an Affiliated Member may be appointed as a Consulting Member of any Standing Committee upon the approval of the Committee of Direction.
3. **LIFE MEMBERS:** Life membership may be conferred upon members who retire from active work. They shall have been active in the affairs of the Signal Section and its predecessors and their total term of membership shall have been not less than twenty-five years. Their rights and privileges shall be continued without change. A proposal to confer Life Membership must be signed by five voting representatives of Member

Roads and five representatives of Member Roads, stating their reason for making such proposal. Proposal shall be duly considered at a meeting of the Committee of Direction and then submitted to a vote by letter to the Committee of Direction membership for approval.

Officers and Committees

4. The Officers of the Section shall consist of a Chairman, First Vice-Chairman, Second Vice-Chairman, and Secretary.

- (a) The Chairman and Vice-Chairmen shall be selected by the Committee of Direction on or before November 1st. Their terms of office shall be one year from January 1st or until their successors are selected and qualified. A Chairman or Vice-Chairman having served a full term shall not succeed himself.
- (b) The Secretary will be appointed by the Committee of Direction. His salary shall be named by that Committee subject to the approval of the Vice-President, Operations and Maintenance Department of the Association.
- (c) The COMMITTEE OF DIRECTION will consist of twelve members, as follows: The Chairman, the First Vice-Chairman, the Second Vice-Chairman, the latest Past Chairman, one member from New England or Canada, three members from the East, one member from the South and three members from the West.

The territorial representatives, except when filling vacancies, shall serve four years and their term of office will expire on December 31st of the fourth year.

Vacancies in official positions or of territorial representatives shall be filled until the next election, by the Committee of Direction.

One Vice-Chairman shall be selected from Eastern Territory and one from Western Territory. For this purpose the Eastern Territory will consist of all territory operating under Eastern and Atlantic Standard Time. All other territory will be known as Western Territory. The location of the official's headquarters will determine whether he is in the Eastern or Western territory.

- (d) The Standing Committees of the Section will be as follows:
- I—Economics of Railway Signaling
 - II—Interlocking
 - III—Automatic Train Control and Signals
 - IV—Automatic Block Signaling
 - V—Contracts and Instructions
 - VI—Designs
 - VII—Materials Research
 - VIII—Highway Grade Crossing Protection
 - IX—Overhead and Underground Lines
 - X—Signaling Practice
 - XI—Electronics
 - XII—Circuit Design

The representation of Member Roads on these committees will be, when practicable, territorially selected, in approximately the same proportion as that of the Committee of Direction, the personnel to be named each year by the Committee of Direction immediately following the adjournment of the Annual meeting.

Duties of Officers

5. The CHAIRMAN shall have general supervision over the affairs of the Section and shall preside at meetings of the Section and at meetings of the Committee of Direction.
6. The FIRST VICE-CHAIRMAN, in the absence of the Chairman, shall perform the duties of the Chairman. He shall perform such other duties as may be assigned to him by the Chairman.
7. The SECOND VICE-CHAIRMAN, in the absence of both the Chairman and First Vice-Chairman, shall perform the duties of the Chairman. He shall perform such other duties as may be assigned to him by the Chairman.
8. (a) The SECRETARY shall devote his entire time to the work of the Section and will perform the usual duties of that office and such other duties as may be assigned to him by the Chairman.
(b) He shall receive on or before November 20th of each year the report of the Committee on Nominations, as elsewhere provided for, and will submit to the voting representatives of Member Roads, not later than November 29th, for letter ballot vote, the nominations contained in that report, to fill the vacancies in the membership of the Committee of Direction. He shall appoint three Tellers from representatives of Member Roads to assist him in counting the ballots, who shall certify the count thereof, with him, to the Committee of Direction. He shall announce the result of the ballot to the Members promptly.
(c) He shall furnish, free of charge, to each representative of a Member Road, designated by such road, one copy of all circulars, Advance Notices and Minutes.
(d) He shall furnish to each Railroad Affiliated, Affiliated and Life Member one copy of all circulars, Advance Notices and Minutes.

Duties of Committees

9. The COMMITTEE OF DIRECTION shall:
 - (a) Exercise general supervision over the interests and affairs of the Section.
 - (b) Be empowered to act on behalf of the Section in the interim between meetings and submit at each meeting a report covering its actions.
 - (c) Examine and decide what portion of communications, papers and reports shall be submitted to the meetings. It shall determine which, if any, of the subjects presented by the various committees shall be referred to the General Committee of the Engineering Division.

- (d) Appoint on or before October 1st of each year a Committee on Nominations consisting of representatives of five Member Roads, who shall not be members of the Committee of Direction.
 - (e) Appoint additional committees as required.
 - (f) Submit to the Vice-President, Operations and Maintenance Department, detail of contemplated financial requirements for conducting the work of the Section as required or as called for by that official.
 - (g) Call Annual meetings of the Section if in its judgment conditions warrant.
 - (h) Call meetings of the Section upon not less than thirty days' notice to each member. It **MUST** call a special meeting of the Section upon the request in writing of a majority of the voting members of Member Roads.
 - (i) Publish Manual of Recommended Practice, in which shall be included such approved Specifications, Drawings, Findings and Conclusions of the Section as the Committee of Direction may find advisable.
10. The COMMITTEE ON NOMINATIONS, appointed as prescribed above, shall report to the Secretary on or before November 20th each year at least two nominations for each impending vacancy to replace the territorial representatives on the Committee of Direction.

The duties of the Standing Committees shall be as follows:

- 11. COMMITTEE I—ECONOMICS OF RAILWAY SIGNALING. Study and report on the economy, if any, of the various signal systems, interlocking, train control, cab signals and other signaling projects.
- 12. COMMITTEE II—INTERLOCKING. Prepare specifications for the various types of interlockings and submit reports on subject-matters relating thereto.
- 13. COMMITTEE III—AUTOMATIC TRAIN CONTROL AND SIGNALS. Report on Federal, State and Dominion activities on automatic train stop, automatic train control, automatic cab signaling, signals, interlocking, highway grade crossing protection, and related safety devices.
- 14. COMMITTEE IV—AUTOMATIC BLOCK SIGNALING. Prepare specifications for the various types of automatic block systems and submit reports on subject-matters relating thereto.
- 15. COMMITTEE V—CONTRACTS AND INSTRUCTIONS. Prepare recommended forms for use in connection with signaling contracts and prepare instructions relating to signal maintenance.
- 16. COMMITTEE VI—DESIGNS. Prepare detailed drawings for standardization purposes and make any special study or investigation assigned to it by the Committee of Direction.

17. **COMMITTEE VII—MATERIALS RESEARCH.** Make such investigation of materials used in connection with signaling as directed by the Committee of Direction and submit reports on its conclusions.
18. **COMMITTEE VIII—HIGHWAY GRADE CROSSING PROTECTION.** Prepare requisites for highway grade crossing protection and submit matters of interest relating thereto.
19. **COMMITTEE IX—OVERHEAD AND UNDERGROUND LINES.** Prepare specifications for overhead and underground lines and any recommendations relating to such lines which will be of interest to the Section.
20. **COMMITTEE X—SIGNALING PRACTICE.** Prepare requisites for the various types of interlocking and block signaling systems, make recommendations having reference to the signal indications which should be given as the varied conditions on railroads require, also submit reports on such other matters as may be assigned by the Committee of Direction.
21. **COMMITTEE XI—ELECTRONICS.** Investigate and report on the use of electronics in connection with railway signal systems, interlocking, centralized traffic control, and highway grade crossing protection.
22. **COMMITTEE XII—CIRCUIT DESIGN.** Prepare typical circuits representative of approved practices and requisites for railroad signaling.
23. **REPRESENTATION OF THE SECTION UPON GENERAL COMMITTEE OF THE ENGINEERING DIVISION:** The five representatives of the Signal Section upon the General Committee of the Engineering Division shall be the Chairman, First Vice-Chairman, Second Vice-Chairman, and two members of the Committee of Direction to be selected by it.
24. **RECOMMENDED PRACTICES:**

Any definition, nomenclature, specification, recommended construction or recommended practice or any proposition having for its objective the formal declaration of the Section upon any matter of importance shall be presented in writing (accompanied by drawings if the latter are necessary for a clear understanding of the subject).

Such submissions will be presented to the Section at its Annual meeting for discussion, and following vote to decide whether or not the proposition shall be submitted to the voting members of Member Roads for adoption or rejection by letter ballot. If the vote to submit is affirmative, the Secretary within three months from the date of the meeting will distribute the ballots with a copy of the Minutes of the meeting, requesting their return within thirty days, naming the date. Ballots mailed after that date, as shown by the postmark, will not be counted. The Secretary shall announce the result of the ballot promptly to the Members. Ballots

and envelopes shall be preserved for at least two years from date of announcement. The voting power of the Member Roads shall be as named in paragraph 26.

25. **VOTING AT MEETINGS OF SECTION:** Vote may be taken viva voce, by rising, by roll call or by ballot. Each Member Road shall be entitled to one vote, the ranking officer of a road present at any meeting being recognized as the voting representative of that road, unless otherwise designated by it. The vote of a majority of the Member Roads represented shall be required to decide any question, motion or resolution unless otherwise ordered, except that in the consideration of submitting a question to the letter ballot vote of the Member Roads, all representatives of Member Roads present at any meeting may vote. Thirty representatives of Member Roads shall constitute a quorum.

26. **LETTER BALLOTS:**

Letter ballots may be taken upon any subject by order of the Committee of Direction and *must* be taken on all questions affecting physical property. The voting power of the Member Roads shall be proportionate to ownership of signal equipment, one vote being counted for each

- 400 signals operating in two positions;
- 250 signals operating in three or four positions;
- 200 interlocked switches, power operated;
- 400 interlocked switches, manually operated;
- 250 highway crossings, automatically protected;
- 1600 train control inductors or loop circuits;
- 800 train control ramp (energized) magnet or coded circuits.

A fraction of a vote in the total of all items, if greater than one-half, shall be counted as one. Each Member Road shall have at least one vote.

Any proposition for which a majority of the votes are affirmative, shall be considered adopted.

27. **ORDER OF BUSINESS:** The order of business at meetings of the Section shall, unless otherwise directed by a majority of the members present, be as follows:

- Approval of Minutes of Last Meeting;
- Reports of Standing Committees;
- Reports of Special Committees;
- Unfinished Business;
- New Business.

28. Roberts' Rules of Order shall govern the proceedings of the Section, including amendment of these Rules of Order.

Sept. 1948]

RESULT OF LETTER BALLOT ON SUBJECTS APPROVED AT
THE ANNUAL MEETING, SEPTEMBER 11, 12 AND 13, 1947

All subjects have received the required affirmative letter ballot vote, as follows:

For Against

Committee II—Interlocking

Specification 130-47—Circuit Controller for Movable Bridges. (Superseding Specification 130-40, Manual Part 48.).....	989	0
Specification 215-47—Spring Switch Mechanism. (New.).....	989	0

Committee IV—Automatic Block Signaling

Specification 44-47—Highway Crossing Bell. (Superseding Specification 44-39, Manual Part 21.).....	989	0
Specification 220-47—Electric Switch Lamp. (New.).....	989	0
Specification 222-47—Color Light Switch Signal. (New.).....	989	0
Specification 224-47—Centralized Traffic Control Neutral Direct Current Relay. (New.).....	989	0
Specification 225-47—Low Pass Filter for Centralized Traffic Control Lines Where Telephone Circuit is Superimposed. (New.).....	989	0
Specification 226-47—Tuned Alternator. (New.).....	989	0
Specification 74-47—Impedance Bond. (Superseding sections 1 and 8 of Specification 74-39, Manual Part 67.).....	989	0
Specification 221-47—Retained Neutral Polarized Relay. (New.).....	989	0
Specification 228-47—Tractive Armature Direct Current Biased Neutral Relay. (New.).....	989	0

Committee V—Contracts and Instructions

Definitions for Technical Terms Used in Signaling. (To be in- cluded in Manual Part 55.).....	989	0
Instructions for Alternating Current Relays. (Superseding Instructions 1 to and including 51 of Instructions for Alternating Current Relays, Manual Part 124.).....	989	0
Instructions for Light and Motor Semaphore Signals. (Super- seding Instructions 1 to and including 56, and Table of Operating Characteristics of Searchlight Type Color Light Signals, of Instructions for Light and Motor Semaphore Signals, Manual Part 54.).....	989	0
A.A.R. Sig. Sec. 1662C—Graphical Symbols—Tracks and Highway Crossings. (Superseding A.A.R. Sig. Sec. 1662B in the Manual.).....	986	3
Instructions for Movable Bridge Protected by Signals. (New.)	989	0
Instructions for Maintaining Reflector Signs. (New.).....	989	0

<i>Committee VI—Designs</i>		For	Against
A.A.R. Sig. Sec. 1021C—Guide Clamps for Vertical Connections on Signals. (Superseding A.A.R. Sig. Sec. 1021B in the Manual.)	989	0	
A.A.R. Sig. Sec. 1083C—"U" Bolt and Clamp for Signal Masts. (Superseding A.A.R. Sig. Sec. 1083B in the Manual.)	989	0	
A.A.R. Sig. Sec. 1103B—Concrete Foundation for Horizontal Crank Stands. (Superseding A.A.R. Sig. Sec. 1103A in the Manual.)	989	0	
A.A.R. Sig. Sec. 1104B—Foundation for Compensator. (Superseding R.S.A. 1104 in the Manual.)	989	0	
A.A.R. Sig. Sec. 1250B—Base for 5-Inch Mast. (Superseding A.A.R. Sig. Sec. 1250A in the Manual.)	989	0	
A.A.R. Sig. Sec. 1346B—Electric Hand Lantern. (Superseding A.A.R. Sig. Sec. 1346A in the Manual.)	989	0	
A.A.R. Sig. Sec. 1489C—Automatic Crossing Gate and Signal Assembly. (Superseding A.A.R. Sig. Sec. 1489B in the Manual.)	984	5	
A.A.R. Sig. Sec. 1567B—Mechanical Dwarf Signal—Details. (Superseding A.A.R. Sig. Sec. 1567A in the Manual.)	989	0	
A.A.R. Sig. Sec. 1616C—Light Signal Masts. (Superseding A.A.R. Sig. Sec. 1616B in the Manual.)	989	0	
A.A.R. Sig. Sec. 1640C—90 Degree Cast-Iron Crossing Sign. (Superseding A.A.R. Sig. Sec. 1640B in the Manual.)	989	0	
A.A.R. Sig. Sec. 1641C—Double Adapter Clamp and Details for Crossing Signs for 3 to 8 Inch Pipe. (Superseding A.A.R. Sig. Sec. 1641B in the Manual.)	989	0	
A.A.R. Sig. Sec. 1642D—90 Degree Reflector Crossing Sign Assembly. (Superseding A.A.R. Sig. Sec. 1642C in the Manual.)	989	0	
A.A.R. Sig. Sec. 1643D—90 Degree Reflector Crossing Sign Details. (Superseding A.A.R. Sig. Sec. 1643C in the Manual.)	989	0	
A.A.R. Sig. Sec. 1644C—Cast-Iron Multiple Track Sign. (Superseding A.A.R. Sig. Sec. 1644B in the Manual.)	989	0	
A.A.R. Sig. Sec. 1645C—Reflector Multiple Track Sign. (Superseding A.A.R. Sig. Sec. 1645B in the Manual.)	989	0	
A.A.R. Sig. Sec. 1646C—Reflector Stop on Red Signal Sign. (Superseding A.A.R. Sig. Sec. 1646B in the Manual.)	989	0	
A.A.R. Sig. Sec. 1647D—Single Adapter Clamp and Details for Crossing Signs for 3 to 8 Inch Pipe. (Superseding A.A.R. Sig. Sec. 1647C in the Manual.)	989	0	
A.A.R. Sig. Sec. 1648C—Reflector Stop When Swinging Sign. (Superseding A.A.R. Sig. Sec. 1648B in the Manual.)	989	0	
A.A.R. Sig. Sec. 1650C—Details of Numerals for Track Signs. (Superseding A.A.R. Sig. Sec. 1650B in the Manual.)	989	0	
A.A.R. Sig. Sec. 1651E—Highway Crossing Signal Assembly—Wig-Wag Type. (Superseding A.A.R. Sig. Sec. 1651D in the Manual.)	989	0	

Sept. 1948]

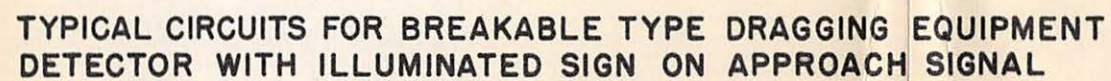
Result of Letter Ballot

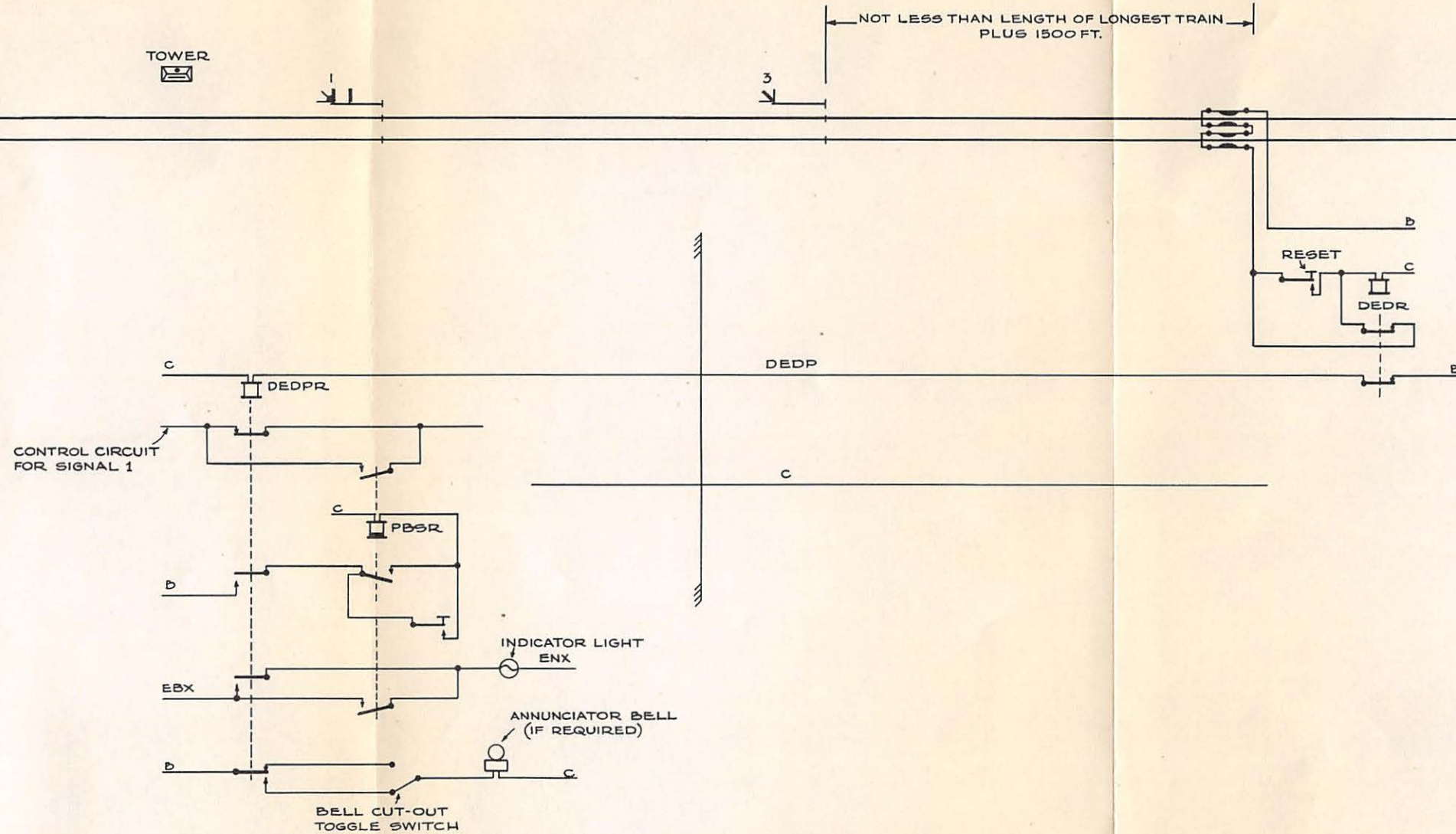
Committee VI—Designs—Continued

For Against

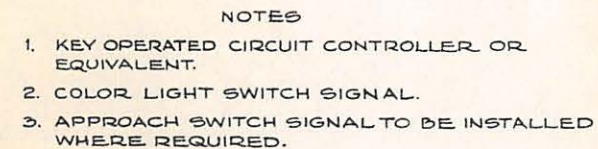
A.A.R. Sig. Sec. 1652E—Highway Crossing Signal Assembly—Wig-Wag Type. (Superseding A.A.R. Sig. Sec. 1652D in the Manual.)	989	0
A.A.R. Sig. Sec. 1653E—Highway Crossing Signal Assembly—Flashing Light Type. (Superseding A.A.R. Sig. Sec. 1653D in the Manual.)	989	0
A.A.R. Sig. Sec. 1654E—Highway Crossing Signal Assembly—Flashing Light Type. (Superseding A.A.R. Sig. Sec. 1654D in the Manual.)	989	0
A.A.R. Sig. Sec. 1655C—Bolts for Crossing Signs for 4 or 5 Inch Pipe. (Superseding A.A.R. Sig. Sec. 1655B in the Manual.)	989	0
A.A.R. Sig. Sec. 1656C—Junction Box and Cross-Arm Assembly for Flashing Light Highway Crossing Signals. (Superseding A.A.R. Sig. Sec. 1656B in the Manual.)	989	0
A.A.R. Sig. Sec. 1657C—Junction Box and Cross-Arm Details for Flashing Light Highway Crossing Signals. (Superseding A.A.R. Sig. Sec. 1657B in the Manual.)	989	0
A.A.R. Sig. Sec. 1686E—Highway Crossing Flashing Light Signal Assembly—6 Ft. and 8 Ft. Cantilever Span. (Superseding A.A.R. Sig. Sec. 1686D in the Manual.)	989	0
A.A.R. Sig. Sec. 1688C—Highway Crossing Flashing Light Signal Assembly—10 Ft. and 12 Ft. Cantilever Span. (Superseding A.A.R. Sig. Sec. 1688B in the Manual.)	989	0
A.A.R. Sig. Sec. 1691D—Highway Crossing Sign—50 Degree Reflector Type. (Superseding A.A.R. Sig. Sec. 1691C in the Manual.)	989	0
A.A.R. Sig. Sec. 1692B—50 Degree Reflector Crossing Sign Assembly. (Superseding A.A.R. Sig. Sec. 1692A in the Manual.)	989	0
A.A.R. Sig. Sec. 1693C—50 Degree Reflector Crossing Sign Details. (Superseding A.A.R. Sig. Sec. 1693B in the Manual.)	989	0
A.A.R. Sig. Sec. 1504B—Lever Number Plate for Mechanical Interlocking Machines. (To be removed from the Manual.)	989	0
A.A.R. Sig. Sec. 1615A—Foundation for Mechanical Dwarf Signals. (To be removed from the Manual.)	989	0
A.A.R. Sig. Sec. 1622A—Tags for Marking Wires. (To be removed from the Manual.)	989	0
A.A.R. Sig. Sec. 1623A—Pattern and Mold for Arbitration Test Bar. (To be removed from the Manual.)	989	0
A.A.R. Sig. Sec. 1649A—Reflector Crossing Signal Marker. (To be removed from the Manual.)	989	0
A.A.R. Sig. Sec. 1696A—Extension Brackets for Crossing Signs. (New.)	989	0
A.A.R. Sig. Sec. 1697A—Bolts for Crossing Signs for 6 Inch Pipe. (New.)	989	0

	For	Against
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A.A.R. Sig. Sec. 1699A—Bolts for Junction Box and Cross-Arm for 4, 5, 6, 8 Inch Pipe. (New.).....	989	0
<i>Committee VII—Materials Research</i>		
Specification 227-47—Target Enamel. (New.).....	989	0
Specification 230-47—Oil for Use as Buffing Agent in Spring Switches. (New.).....	989	0
<i>Committee VIII—Highway Grade Crossing Protection</i>		
Requisites for Automatic Gates—Highway Crossings at Grade Over Railroad Tracks. (Superseding Requisites for Automatic Gates—Highway Crossings at Grade Over Railway Tracks, Manual Part 35.).....	984	5
Specification 231-47—"No Right Turn"—"No Left Turn" Illuminated Sign. (New.).....	989	0
<i>Committee IX—Overhead and Underground Lines</i>		
Specification 223-47—Splices in Rubber-Insulated Conductors and Cables. (New.).....	989	0
Specification for Pole Line Hardware. (Superseding Specification for Pole Line Hardware, Manual Part 51.).....	989	0
Specification 108-47—Copper Bond Wire. (Superseding Specification 10820, Manual Part 175.).....	989	0
Specification 70-47—Forty Per Cent Conductivity Copper-Covered Steel Bonding Wire. (Superseding sections 2, 5 and 6 of Specification 70-39, Manual Part 176.).....	989	0
<i>Committee X—Signaling Practice</i>		
Requisites for Protection for Spring Switches. (Superseding Requisites for Signal Protection for Spring Switches, Manual Part 10.).....	989	0
A.A.R. Sig. Sec. 1291A—Sign—End Automatic Block. (New.).....	963	26
A.A.R. Sig. Sec. 1292A—Sign—End of Block. (New.).....	989	0
A.A.R. Sig. Sec. 1293A—Signs—Begin CTC & End CTC. (New.).....	989	0
A.A.R. Sig. Sec. 1294A—Sign—End of Circuit. (New.).....	963	26
A.A.R. Sig. Sec. 1295A—Sign—Preliminary Section. (New.).....	963	26
Uniform Signal Practice in the Use of Aspects and Indications Employing Flashing Light or Lights for Railway Signaling—Figures 1, 2 and 3. (New.).....	952	37

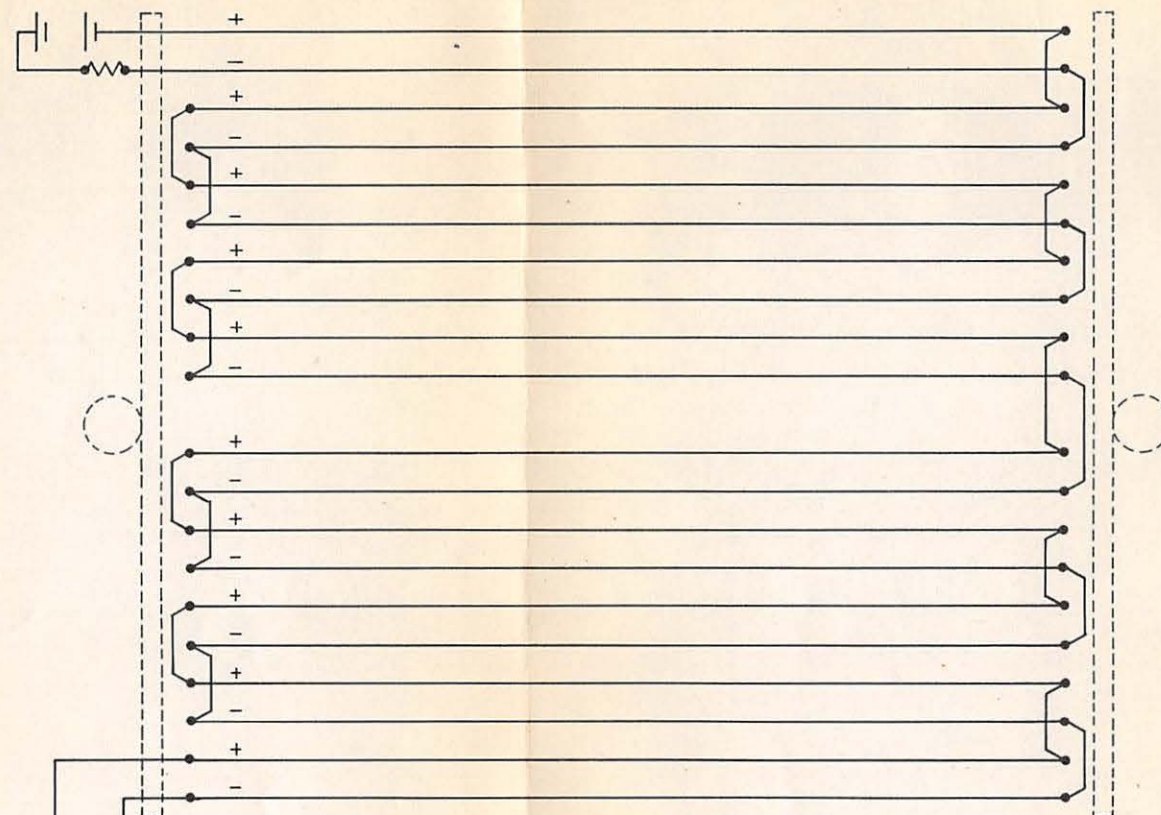




TYPICAL CIRCUITS FOR BREAKABLE TYPE DRAGGING
EQUIPMENT DETECTOR

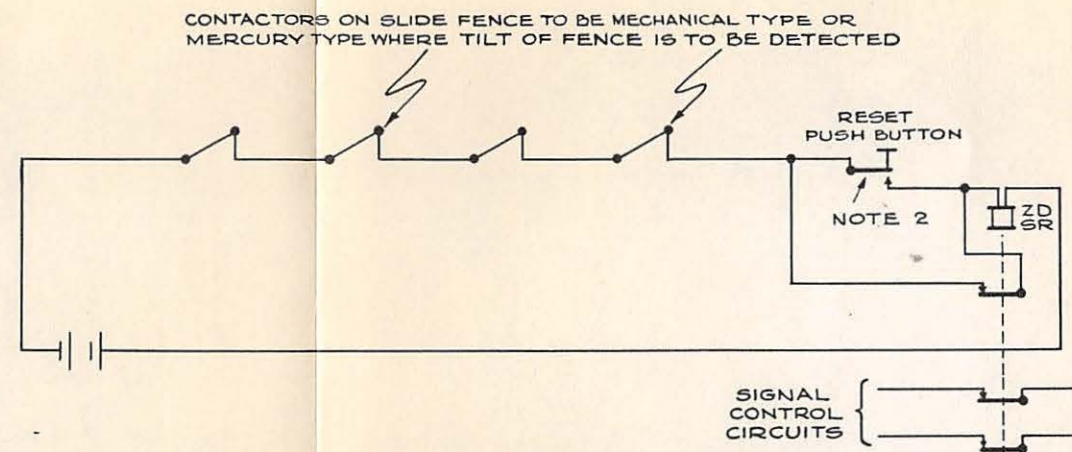
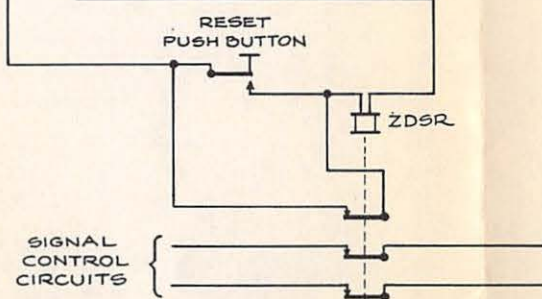


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8014A



**CIRCUIT FOR FALLING
ROCK DETECTOR**

NOTE:
SEE A.A.R. SIG. SEC. DRG. 1505
FOR MECHANICAL DESIGN

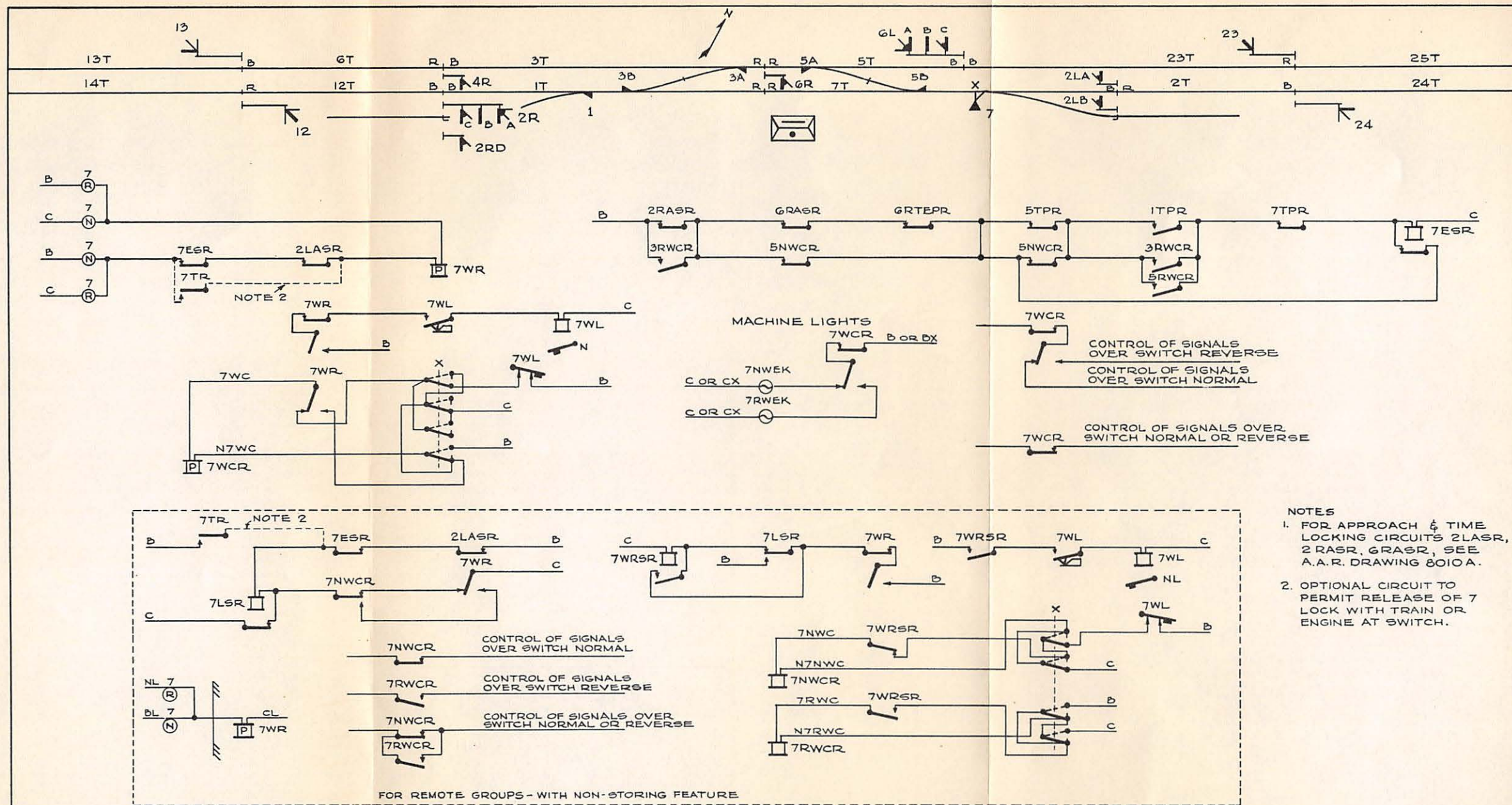


**CIRCUIT FOR ROCK OR EARTH SLIDE
DETECTOR**

NOTES:

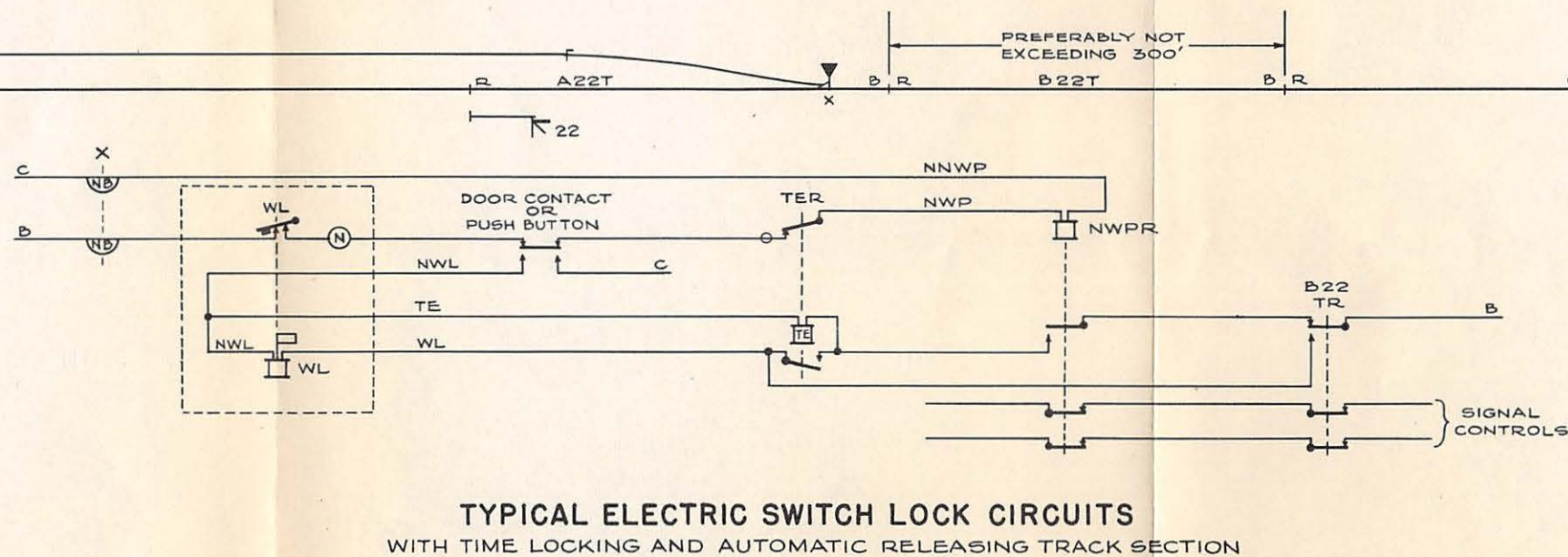
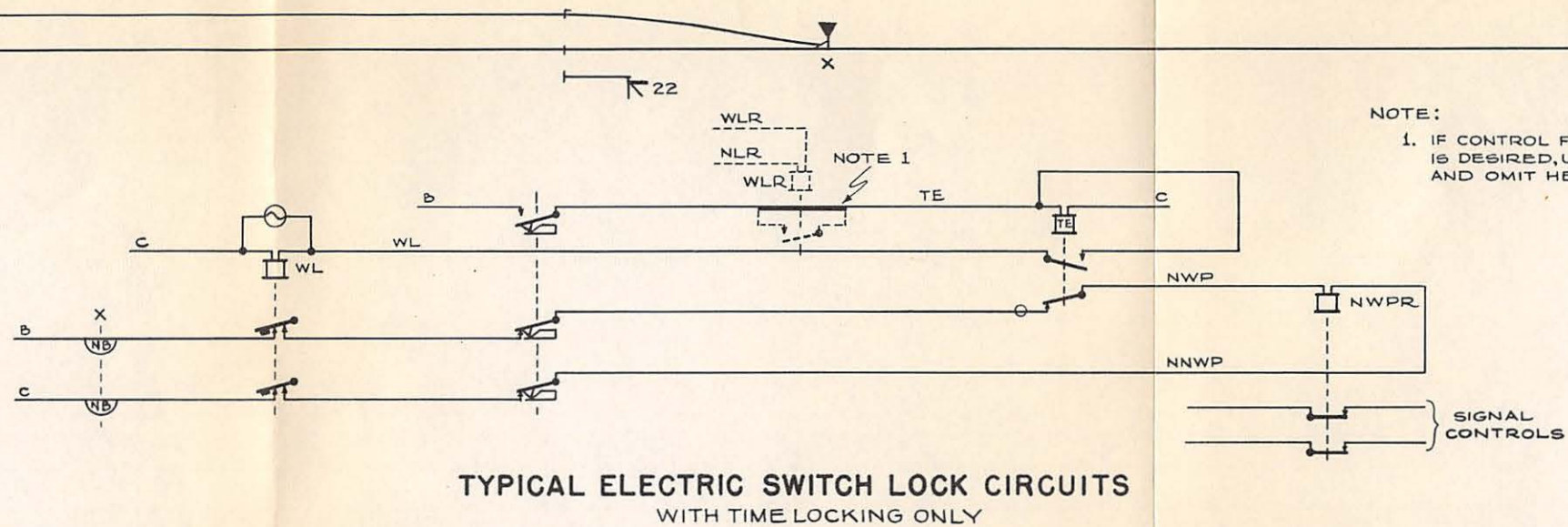
1. SEE A.A.R. SIG. SEC. DRG. 1506 & 1507 FOR MECHANICAL DESIGN OF SLIDE FENCE & LOCATION OF CIRCUIT CONTROLLERS.
2. PUSH BUTTON AND STICK CIRCUIT IN ZDSR ARE NOT REQUIRED WHERE CONTACTORS USED MUST BE MANUALLY RESET.

**TYPICAL CIRCUITS FOR FALLING ROCK AND
EARTH SLIDE DETECTOR**



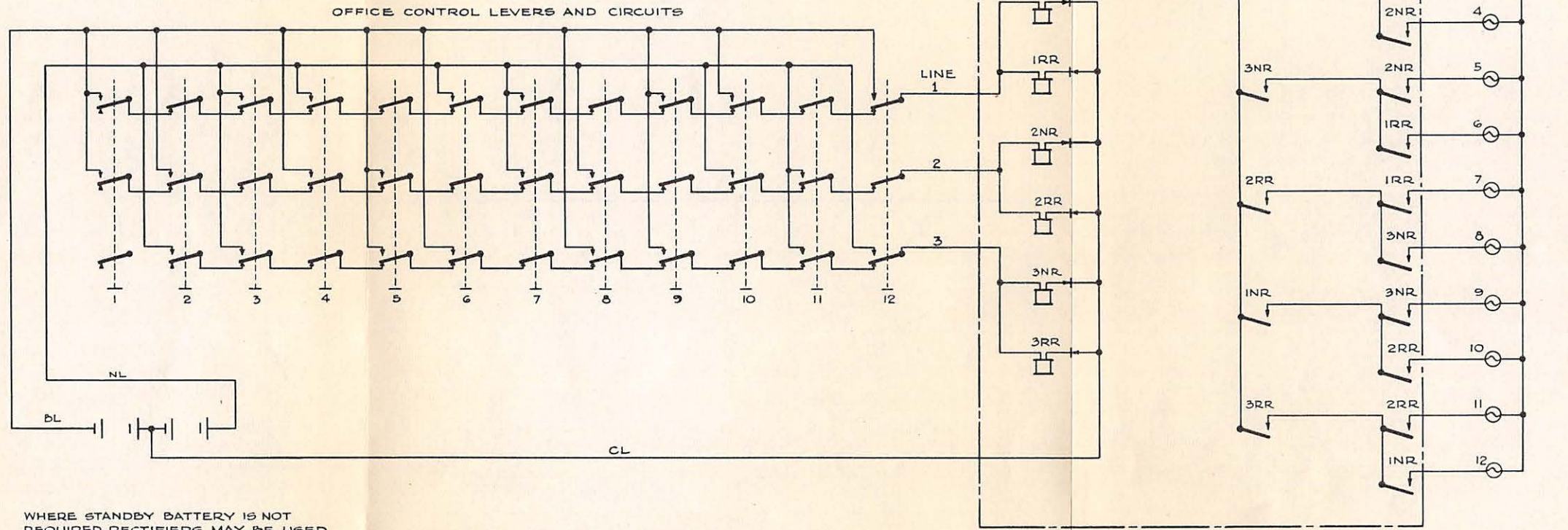
TYPICAL CIRCUITS FOR LEVER CONTROL OF ELECTRIC
SWITCH LOCK WITHIN INTERLOCKING LIMITS.

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8018 A



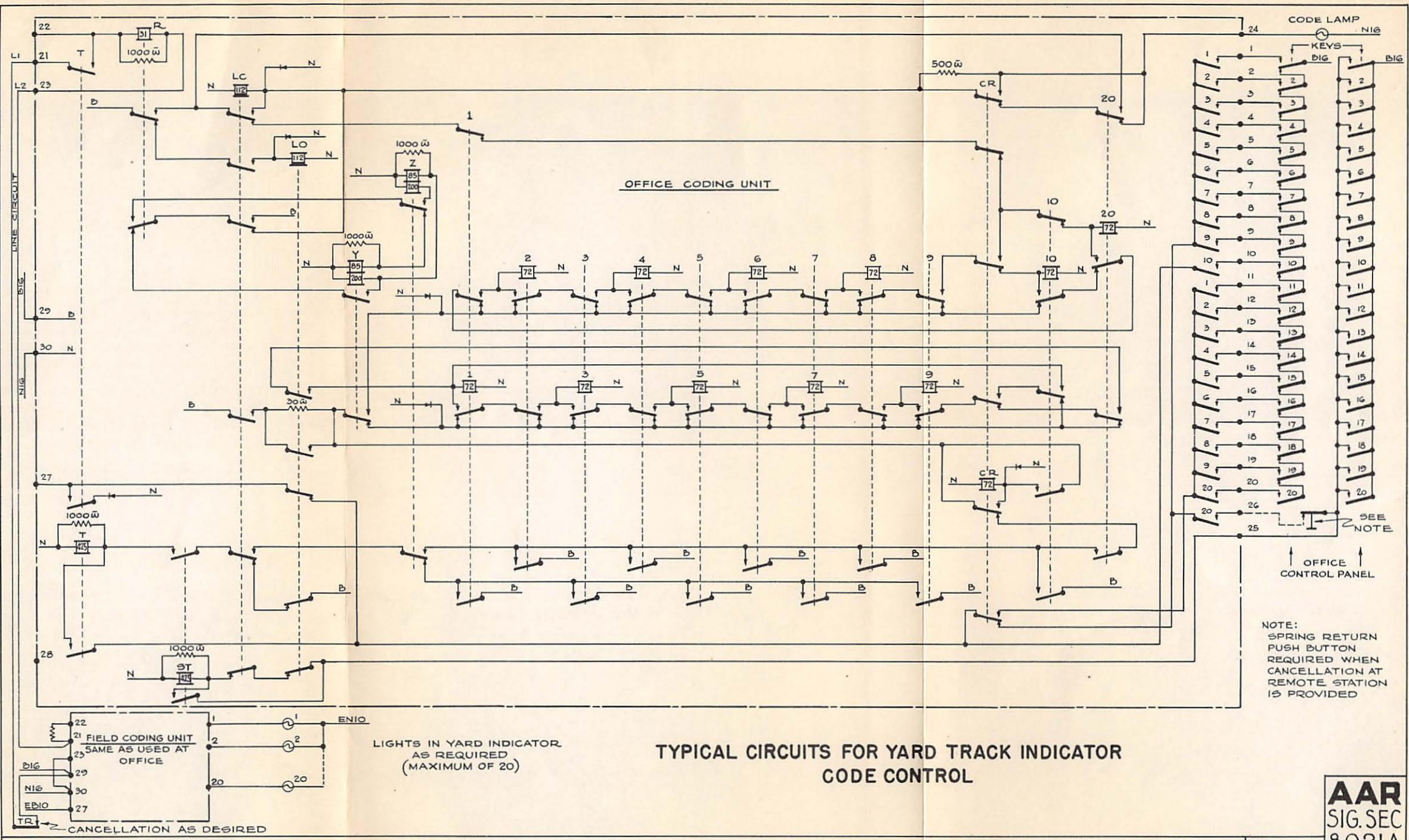
NOTE:
THE NUMBER OF INDICATOR LIGHTS TO BE DISPLAYED WILL GOVERN
THE NUMBER OF LINE WIRES REQUIRED.
FOR EXAMPLE:
12 COMBINATIONS ARE AVAILABLE WITH 3 LINE CONTROL WIRES & COMMON,
ENERGIZED TWO AT A TIME, POSITIVE OR NEGATIVE, AS FOLLOWS

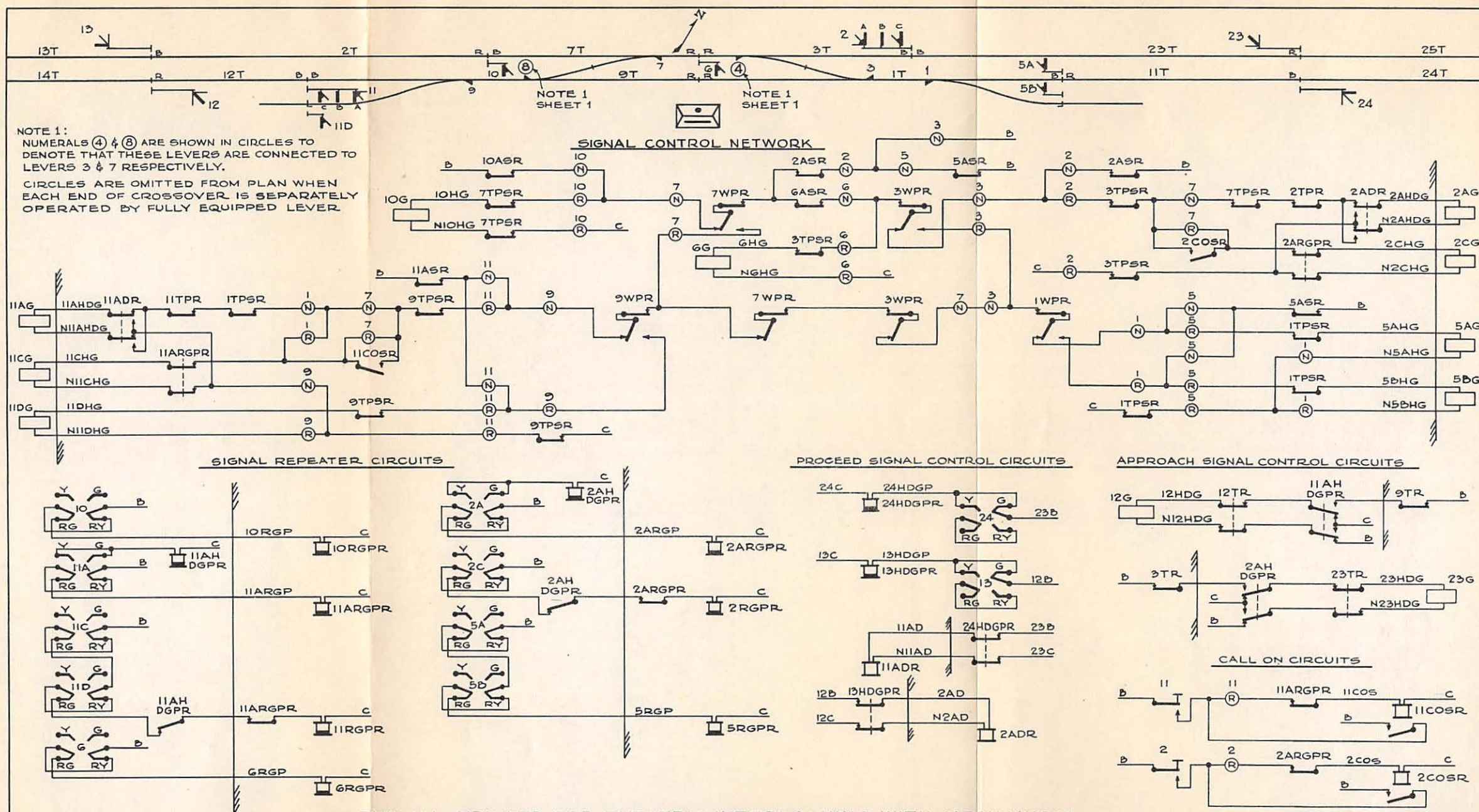
LINE	COMBINATION											
	1	2	3	4	5	6	7	8	9	10	11	12
1	+	-	-	-	-	-	-	-	+	+	-	+
2	+	+	-	+	+	-	-	-	-	-	-	-
3	-	-	-	+	+	+	+	+	+	-	-	-



WHERE STANDBY BATTERY IS NOT
REQUIRED RECTIFIERS MAY BE USED

TYPICAL CIRCUITS FOR YARD TRACK INDICATOR
DIRECT WIRE CONTROL

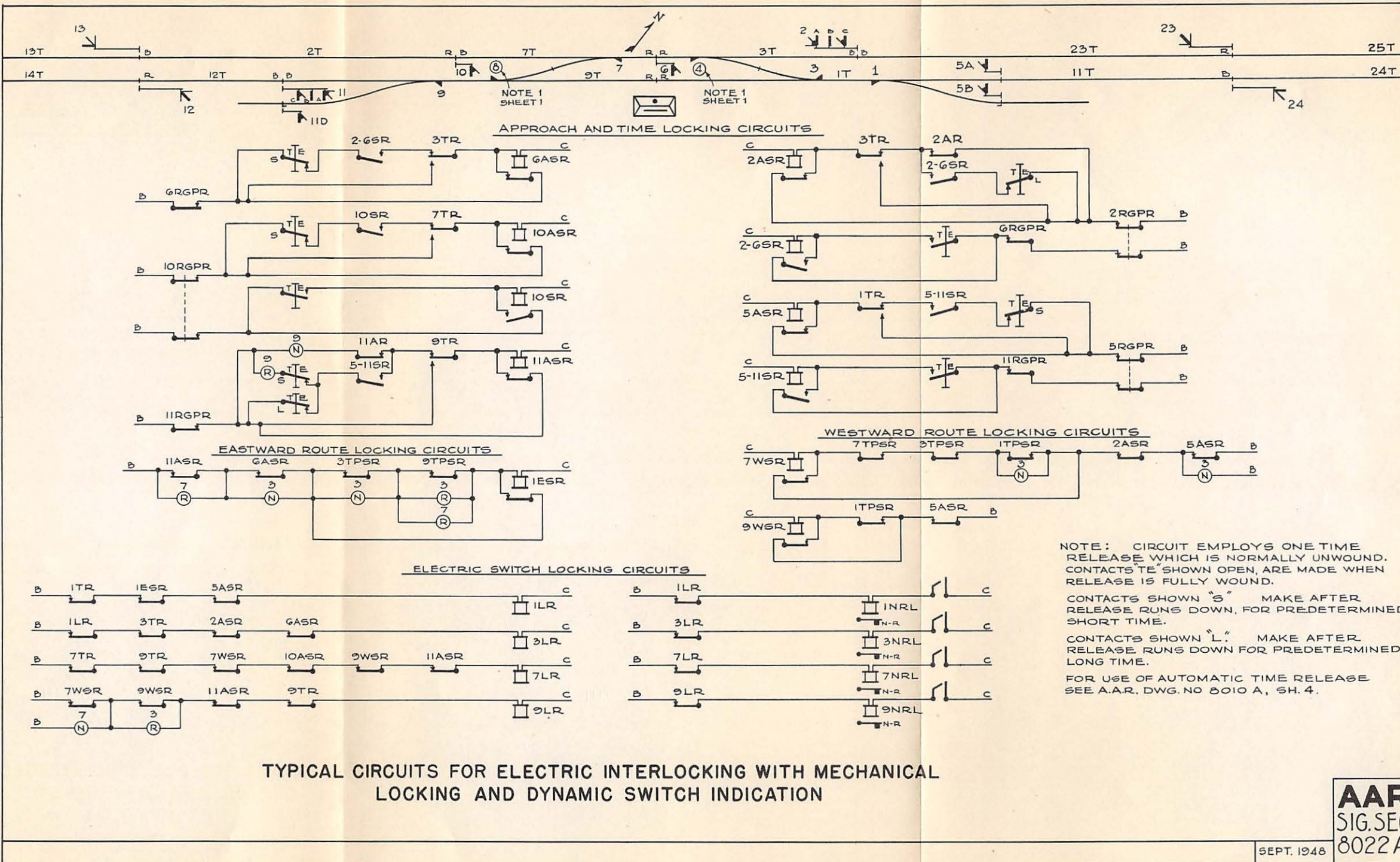


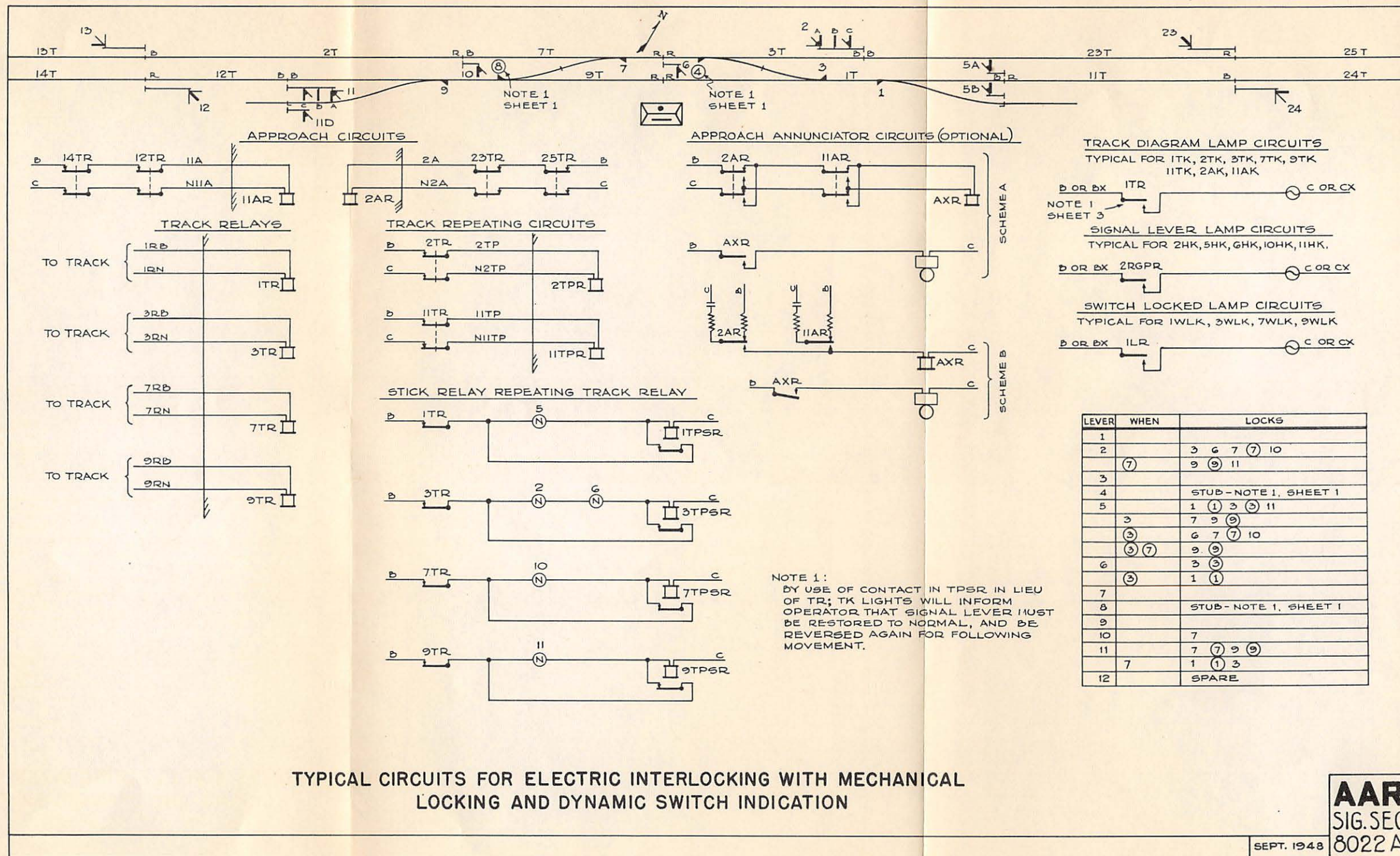


TYPICAL CIRCUITS FOR ELECTRIC INTERLOCKING WITH MECHANICAL
LOCKING AND DYNAMIC SWITCH INDICATION

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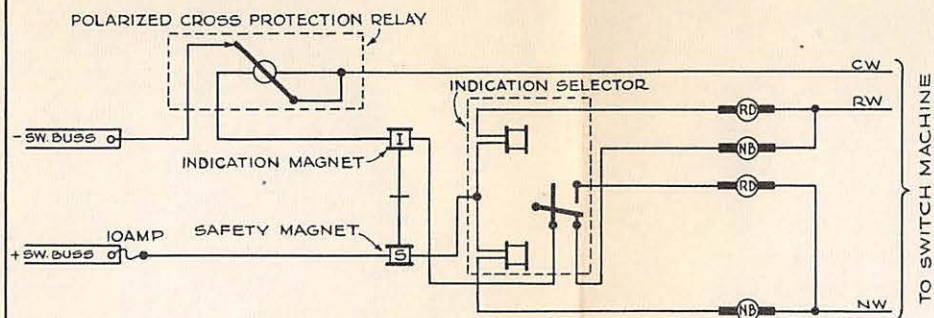
SEPT. 1948



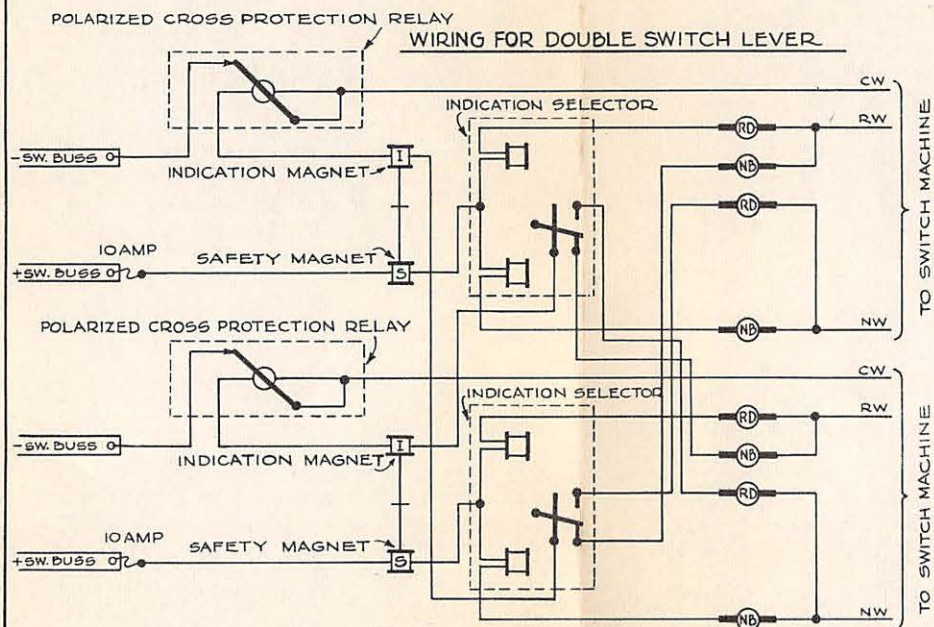


SWITCH CONTROL AND INDICATION CIRCUITS

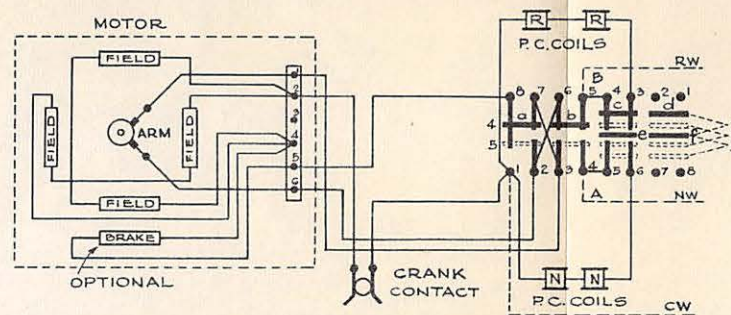
WIRING FOR SINGLE SWITCH LEVER



WIRING FOR DOUBLE SWITCH LEVER



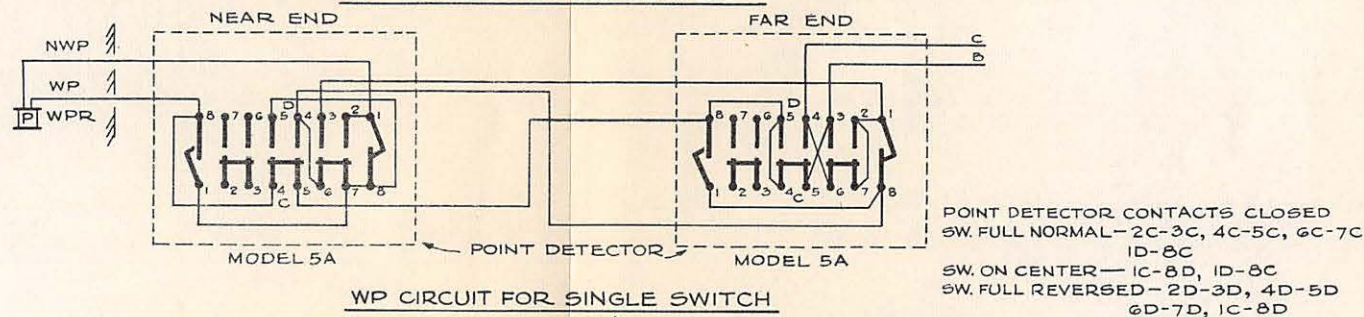
WIRING FOR MODEL 5A SWITCH MACHINE



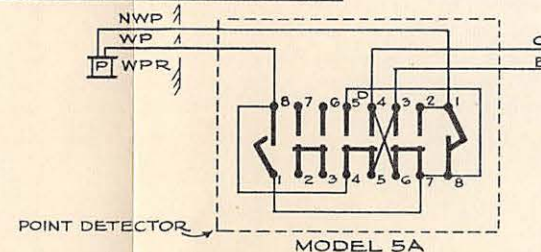
NOTE:

SEQUENCE OF OPERATION FOR MODEL 5A SWITCH MACHINE WITH ELECTRIC POLE CHANGER.
 CONTACT BARS c, d, e, AND f, MOVE FROM POSITION 1 TO POSITION 2 AS THE MACHINE UNLOCKS FROM ITS NORMAL POSITION; THEY THEN MOVE FROM POSITION 2 TO POSITION 3 AS THE MACHINE COMPLETES ITS LOCKING STROKE GOING TOWARD REVERSE.
 CONTACT BARS a AND b MOVE FROM POSITION 4 TOWARD 5 JUST AFTER BARS c, d, e AND f START MOVING FROM 2 TO 3. CONTACT BARS a AND b WILL ALSO MOVE FROM 4 TO 5 OR VICE VERSA, DUE TO THE ATTRACTION OF THE POLE-CHANGER COILS IF THE MACHINE IS REVERSED IN MIDSTROKE.
 CONTACT BARS MOVE IN A SIMILAR MANNER WHEN MACHINE IS OPERATED FROM REVERSE TO NORMAL; THAT IS, BARS c, d, e AND f, GO FROM 3 TO 2 TO 1; AND BARS a AND b GO FROM 5 TO 4.

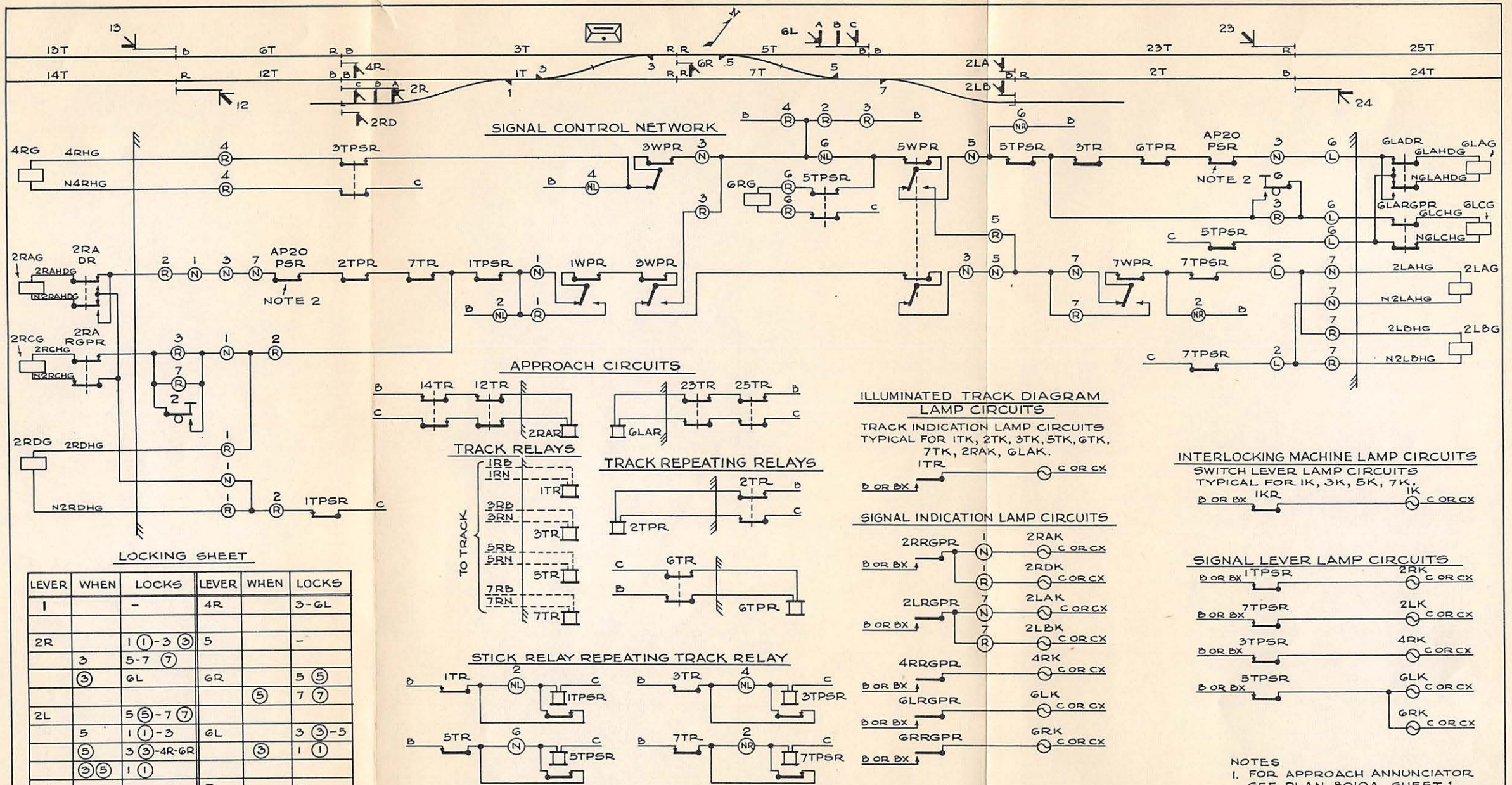
WP CIRCUIT FOR CROSSOVER



WP CIRCUIT FOR SINGLE SWITCH



TYPICAL CIRCUITS FOR ELECTRIC INTERLOCKING WITH MECHANICAL
 LOCKING AND DYNAMIC SWITCH INDICATION



LOCKING SHEET

LEVER	WHEN	LOCKS	LEVER	WHEN	LOCKS
1		-	4R		3-GL
2R		1 (1) - 3 (3)	5		-
	3	5-7 (7)			
	(3)	6L	6R		5 (5)
				(5)	7 (7)
2L		5 (5) - 7 (7)			
	5	1 (1) - 3 (3)	6L		3 (3) - 5 (5)
	(5)	3 (3) - 4R - 6R		(3)	1 (1)
	(3) (5)	1 (1)			
3		-	7		-

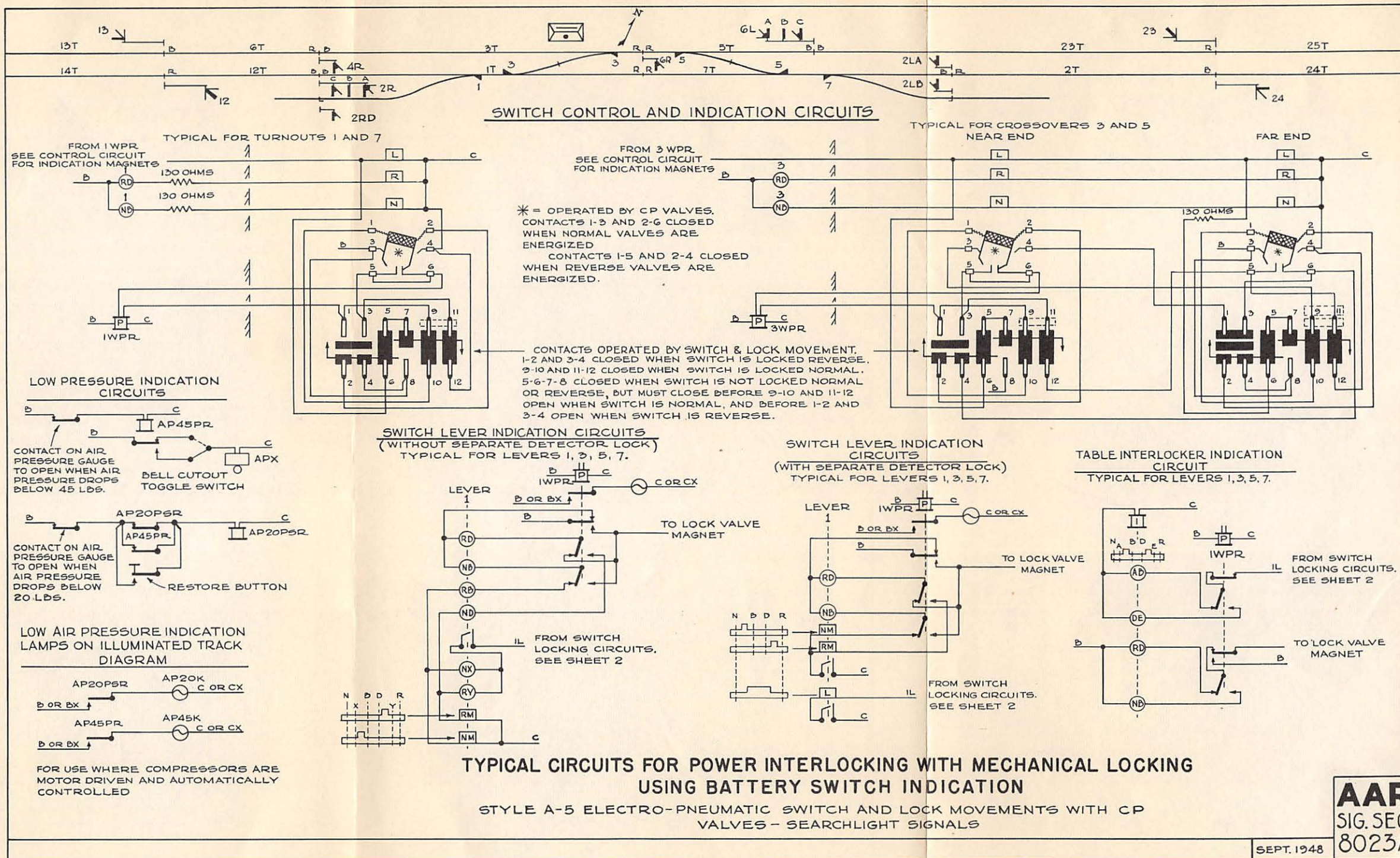
**TYPICAL CIRCUITS FOR POWER INTERLOCKING WITH MECHANICAL LOCKING
 USING BATTERY SWITCH INDICATION.**

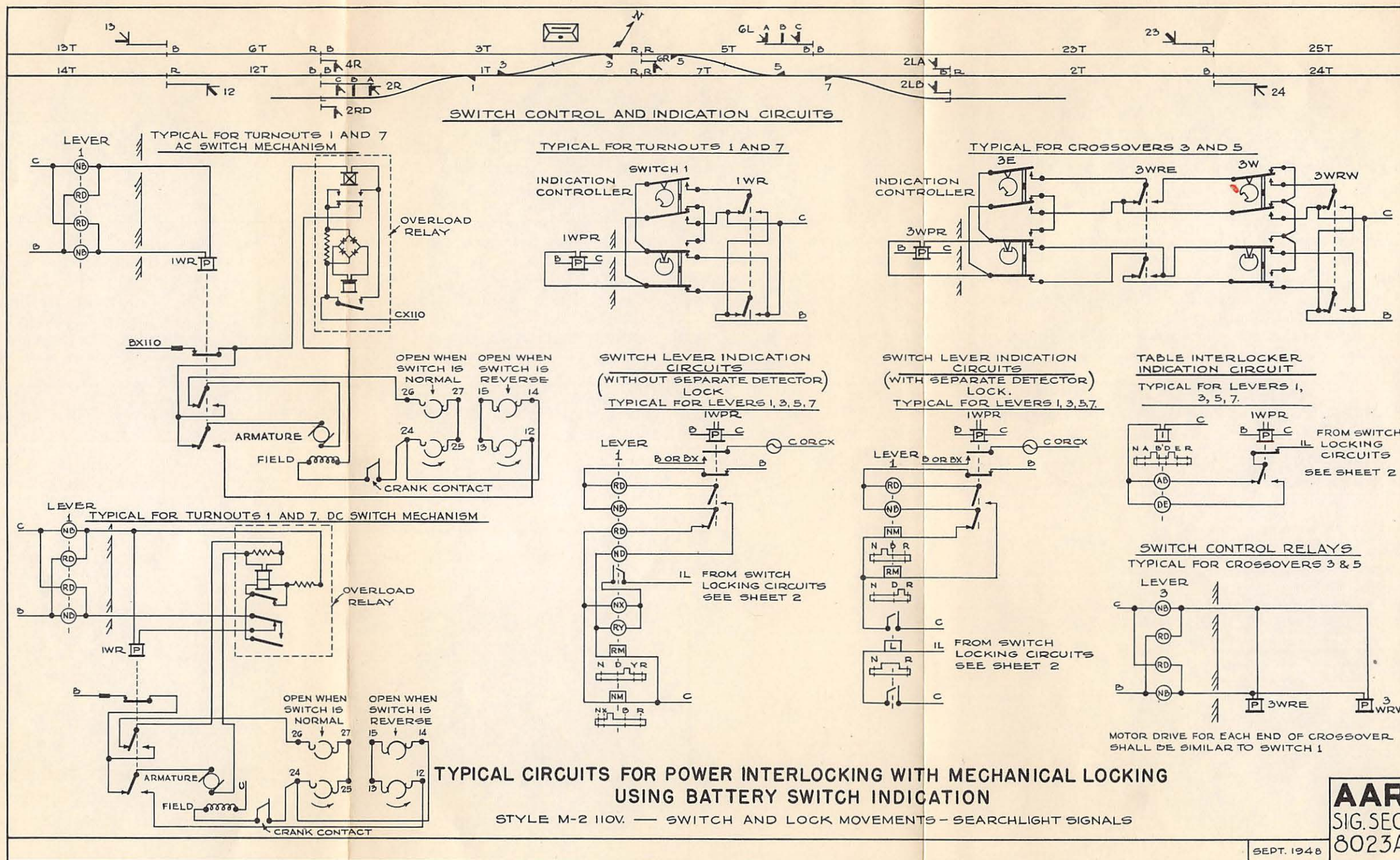
POWER OPERATED SWITCH AND LOCK MOVEMENTS - SEARCHLIGHT SIGNALS

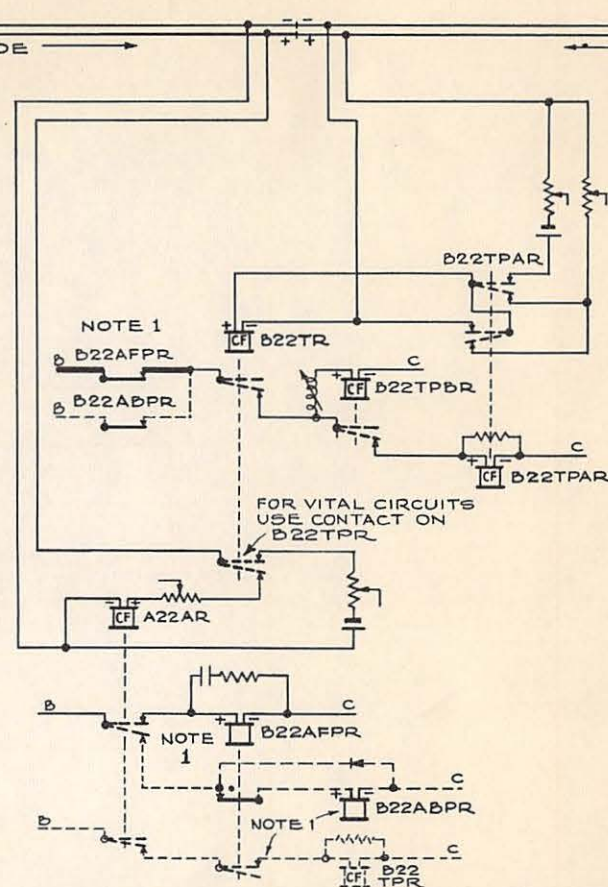
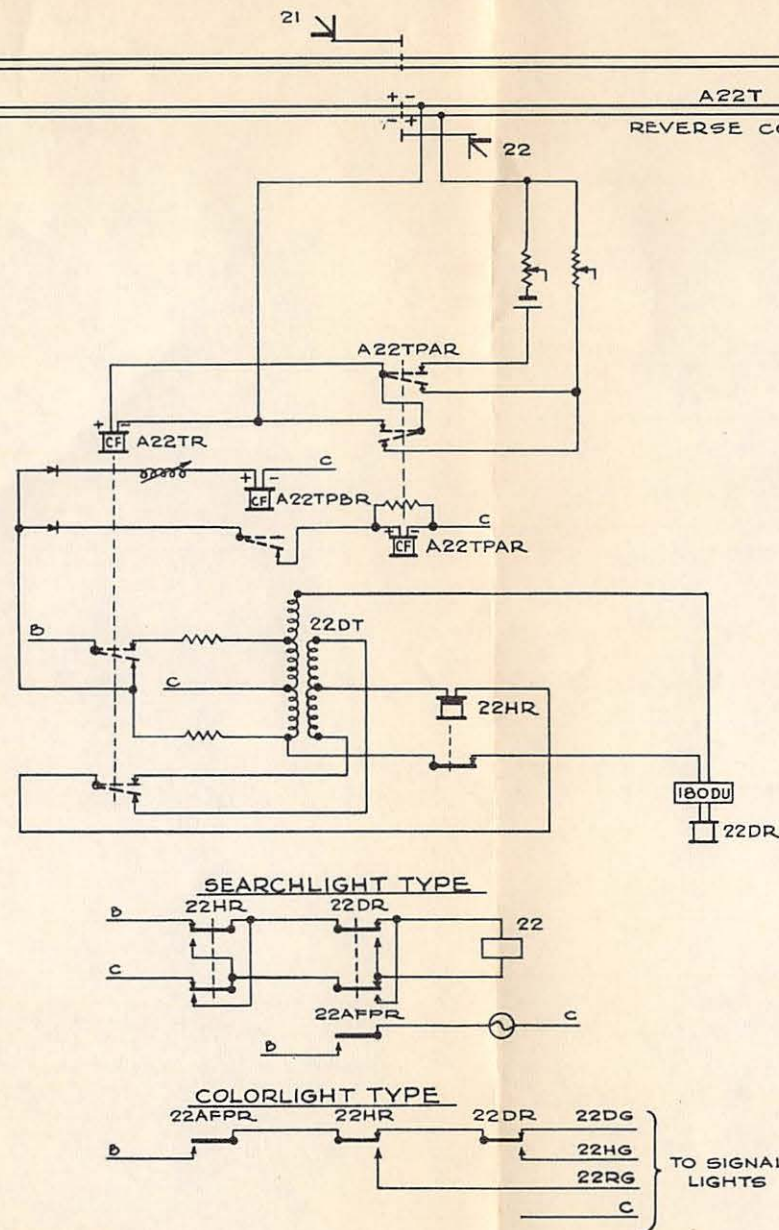
- NOTES**
1. FOR APPROACH ANNUNCIATOR SEE PLAN 8010A. SHEET 1.
 2. CONTACT IN AP20PSR REQUIRED FOR EP INTERLOCKING ONLY.

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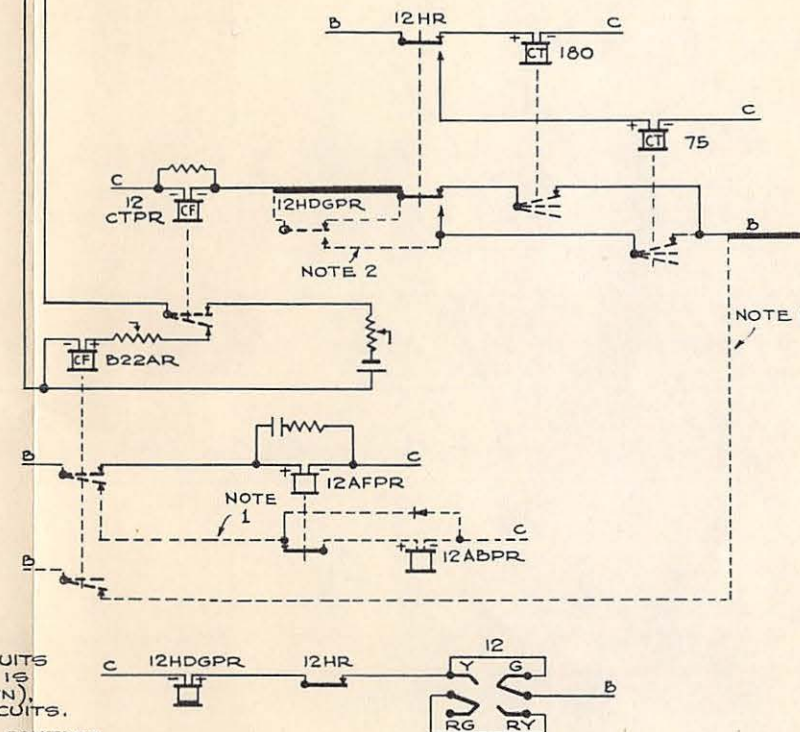


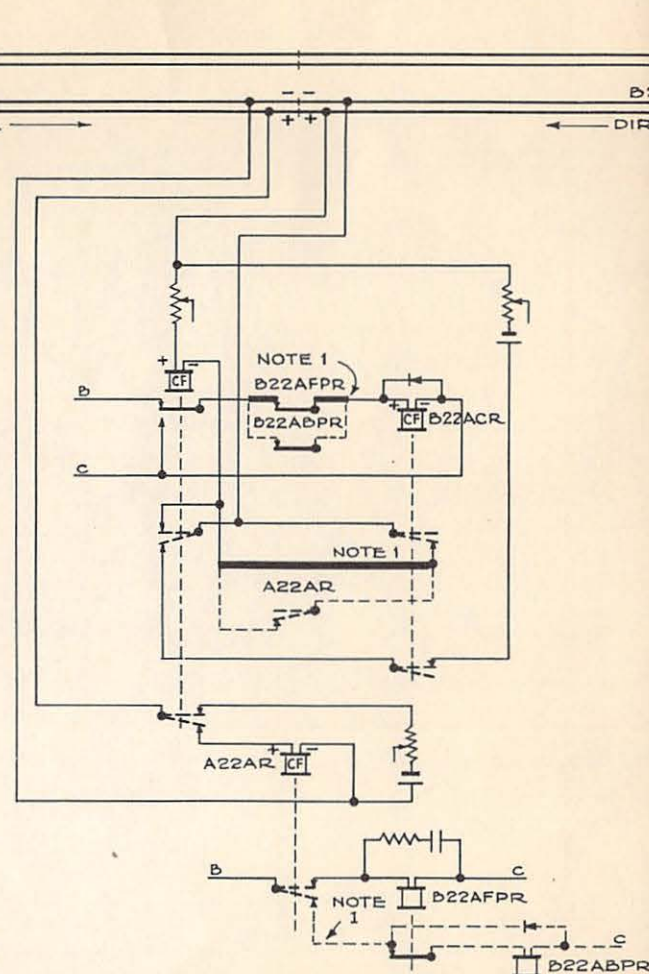
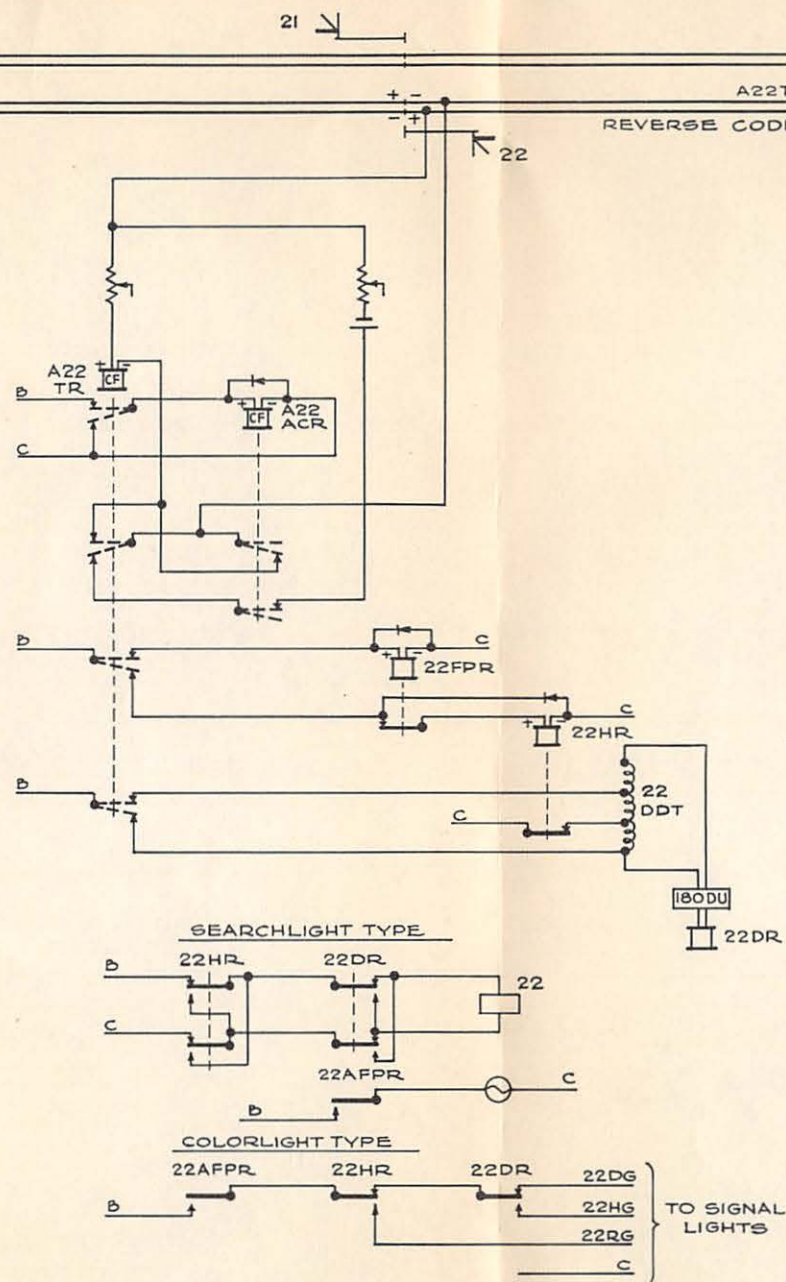


1. WHERE REVERSE CODE IS USED FOR NON-VITAL CIRCUITS OMIT DOTTED LINE CIRCUITS. WHERE REVERSE CODE IS USED FOR VITAL CIRCUITS (APPLICATIONS NOT SHOWN), OMIT HEAVY LINE CIRCUITS AND ADD DOTTED LINE CIRCUITS.
2. FOR SEARCHLIGHT TYPE SIGNALS INCLUDE HDGPR CONTACT AS SHOWN, OMITTING HEAVY LINE CIRCUITS.
3. RADIO INTERFERENCE AND ARC SUPPRESSION DETAILS NOT SHOWN.

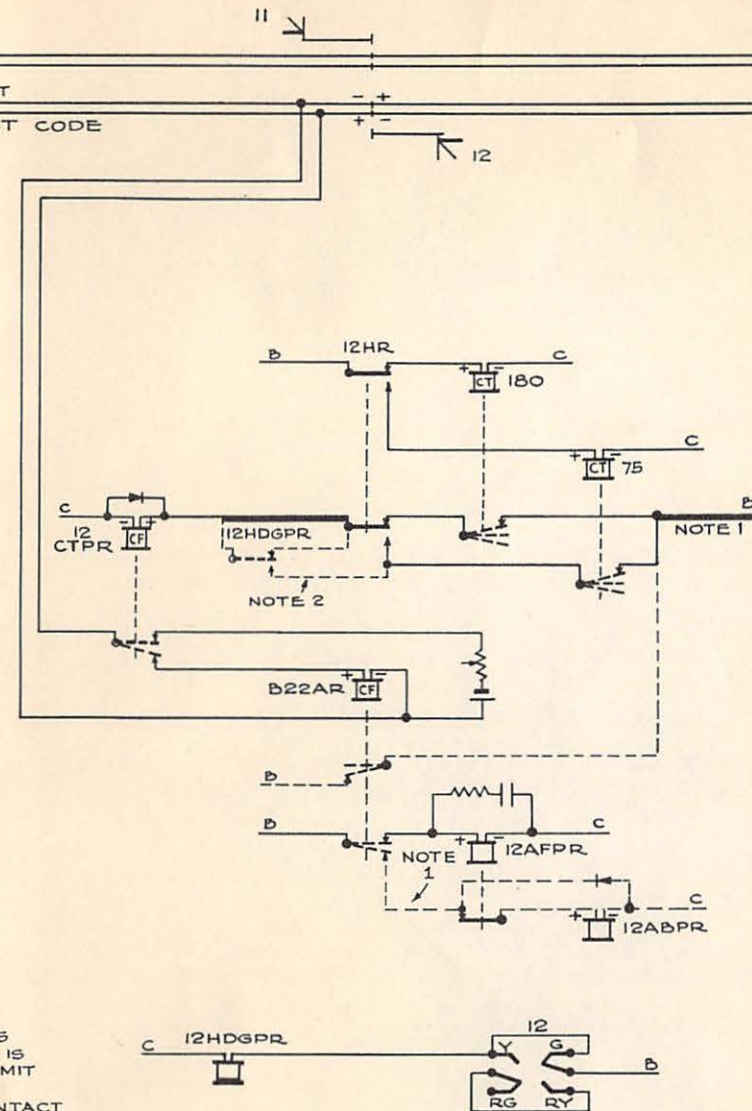
SCHEME 1

TYPICAL CODED TRACK CIRCUITS WITHOUT LINE WIRES USING DIRECT CODE FOR THREE ASPECT AUTOMATIC SIGNALS (CODE RULES 281-285-291) AND USING REVERSE CODE FOR FULL BLOCK APPROACH LIGHTING AND OTHER APPROACH CONTROLS





- NOTES:
1. WHERE REVERSE CODE IS USED FOR NON-VITAL CIRCUITS OMIT DOTTED LINE CIRCUITS. WHERE REVERSE CODE IS USED FOR VITAL CIRCUITS (APPLICATIONS NOT SHOWN) OMIT HEAVY LINE CIRCUITS AND ADD DOTTED LINE CIRCUITS.
 2. FOR SEARCHLIGHT TYPE SIGNALS INCLUDE HDGPR CONTACT AS SHOWN, OMITTING HEAVY LINE CIRCUITS.
 3. RADIO INTERFERENCE AND ARC SUPPRESSION DETAILS NOT SHOWN.



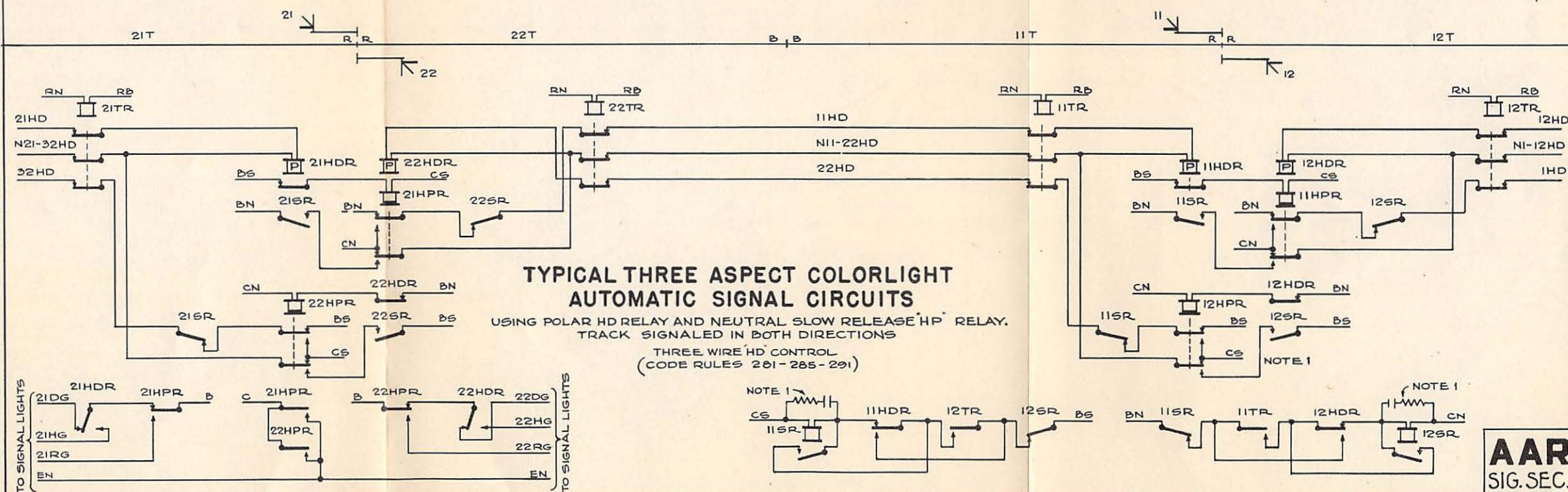
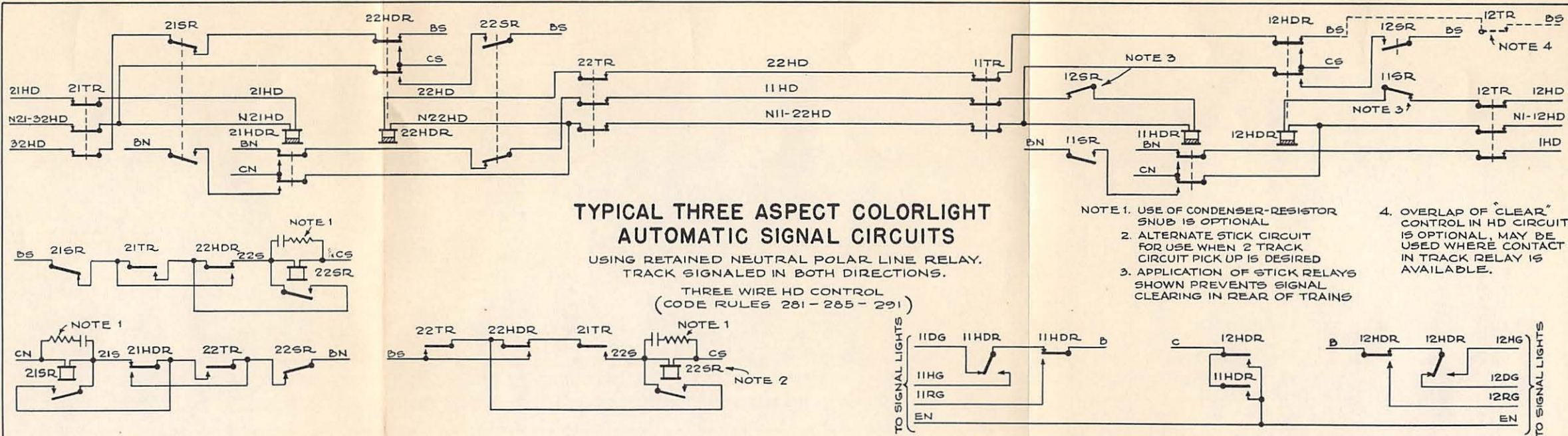
SCHEME 2

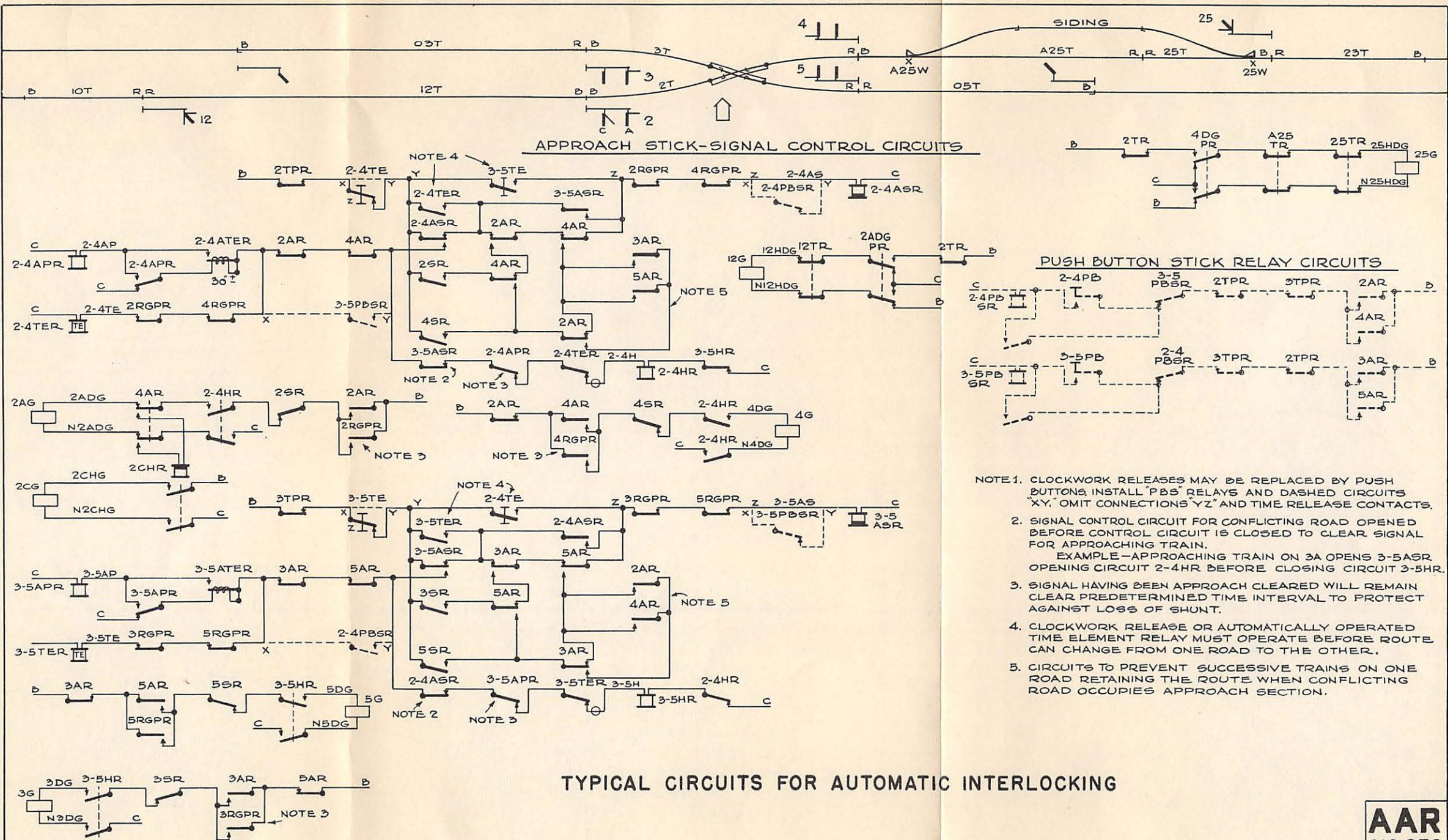
TYPICAL CODED TRACK CIRCUITS WITHOUT LINE WIRES USING DIRECT CODE FOR THREE ASPECT AUTOMATIC SIGNALS (CODE RULES 281-285-291,) AND USING REVERSE CODE FOR FULL BLOCK APPROACH LIGHTING AND OTHER APPROACH CONTROLS

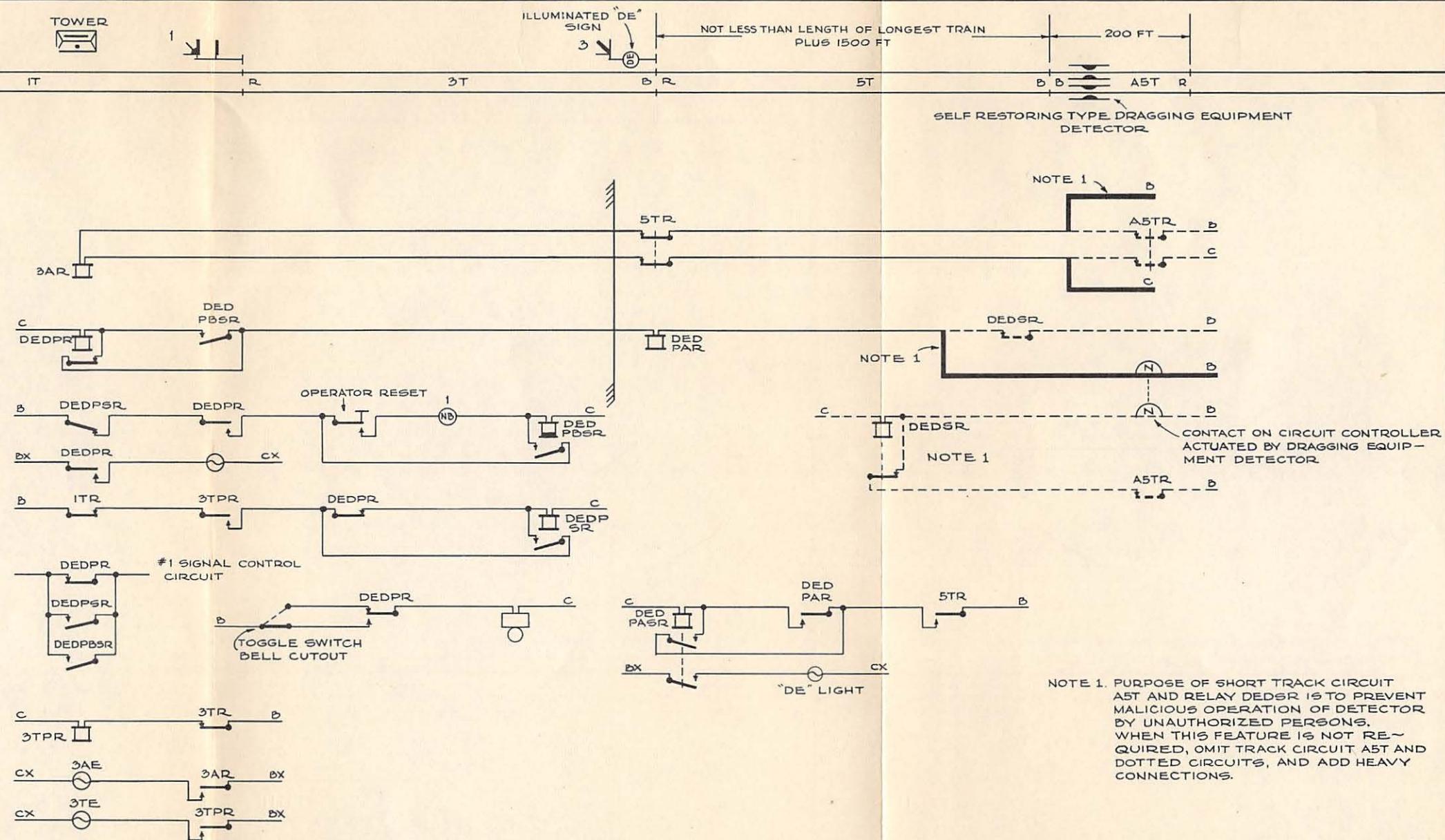
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SHEET 2 OF 2



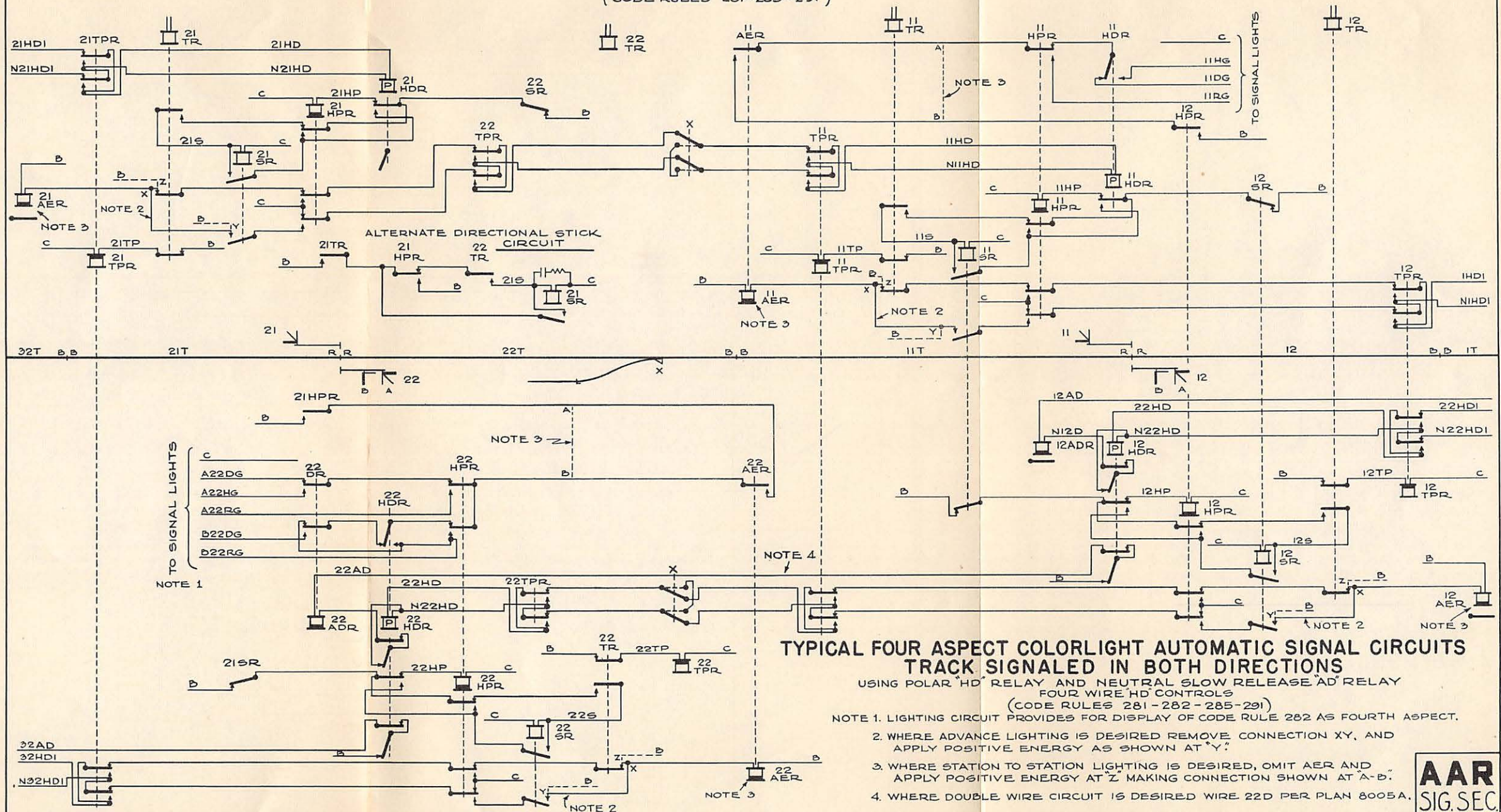




TYPICAL CIRCUITS FOR SELF RESTORING TYPE DRAGGING EQUIPMENT DETECTOR
WITH ILLUMINATED SIGN ON APPROACH SIGNAL

TYPICAL THREE ASPECT COLORLIGHT AUTOMATIC SIGNAL CIRCUITS-TRACK SIGNALLED IN BOTH DIRECTIONS

USING POLAR LINE RELAY
(CODE RULES 281-285-291)



TYPICAL FOUR ASPECT COLORLIGHT AUTOMATIC SIGNAL CIRCUITS TRACK SIGNALLED IN BOTH DIRECTIONS

USING POLAR "HD" RELAY AND NEUTRAL SLOW RELEASE "AD" RELAY
FOUR WIRE "HD" CONTROLS
(CODE RULES 281-282-285-291)

- NOTE 1. LIGHTING CIRCUIT PROVIDES FOR DISPLAY OF CODE RULE 282 AS FOURTH ASPECT.
- NOTE 2. WHERE ADVANCE LIGHTING IS DESIRED REMOVE CONNECTION XY, AND APPLY POSITIVE ENERGY AS SHOWN AT "Y".
- NOTE 3. WHERE STATION TO STATION LIGHTING IS DESIRED, OMIT AER AND APPLY POSITIVE ENERGY AT "Z" MAKING CONNECTION SHOWN AT "A-B".
- NOTE 4. WHERE DOUBLE WIRE CIRCUIT IS DESIRED WIRE 22D PER PLAN 8005A.

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SHEET 1

[illegible]

Diagram illustrating the wiring for Pen Magnets (1 through 6) and associated components:

- Pen Magnets:** Six horizontal lines labeled 1 through 6, each with a box containing its number. The lines are labeled B, b, B, B, B, b on the left and C on the right.
- Components and Connections:**
 - 2AR:** Connected to the top line (B) and the second line (b).
 - 2RGPR:** Connected to the second line (b) and the third line (B).
 - 2TPR:** Connected to the third line (B) and the fourth line (B).
 - 4RGPR:** Connected to the fourth line (B) and the fifth line (B).
 - 4AR:** Connected to the fifth line (B) and the sixth line (b).
 - 2-4TE:** Connected to the sixth line (b) and the seventh line (X).
- 2-4P6GR:** A dashed box containing points X, Z, and Y, connected to the seventh line (X) and the eighth line (Z).
- SEE NOTE 1 SHEET 1:** An arrow points from this text to the dashed box labeled 2-4P6GR.

The diagram illustrates five different configurations of a 2-to-1 multiplexer circuit. Each configuration shows a different set of inputs (Y, G, B, C) connected to the multiplexer's inputs (RG, RY) and outputs (2ADGP, 2CHGP, 2RGP, 4DGP, 3DGP, 5DGP).

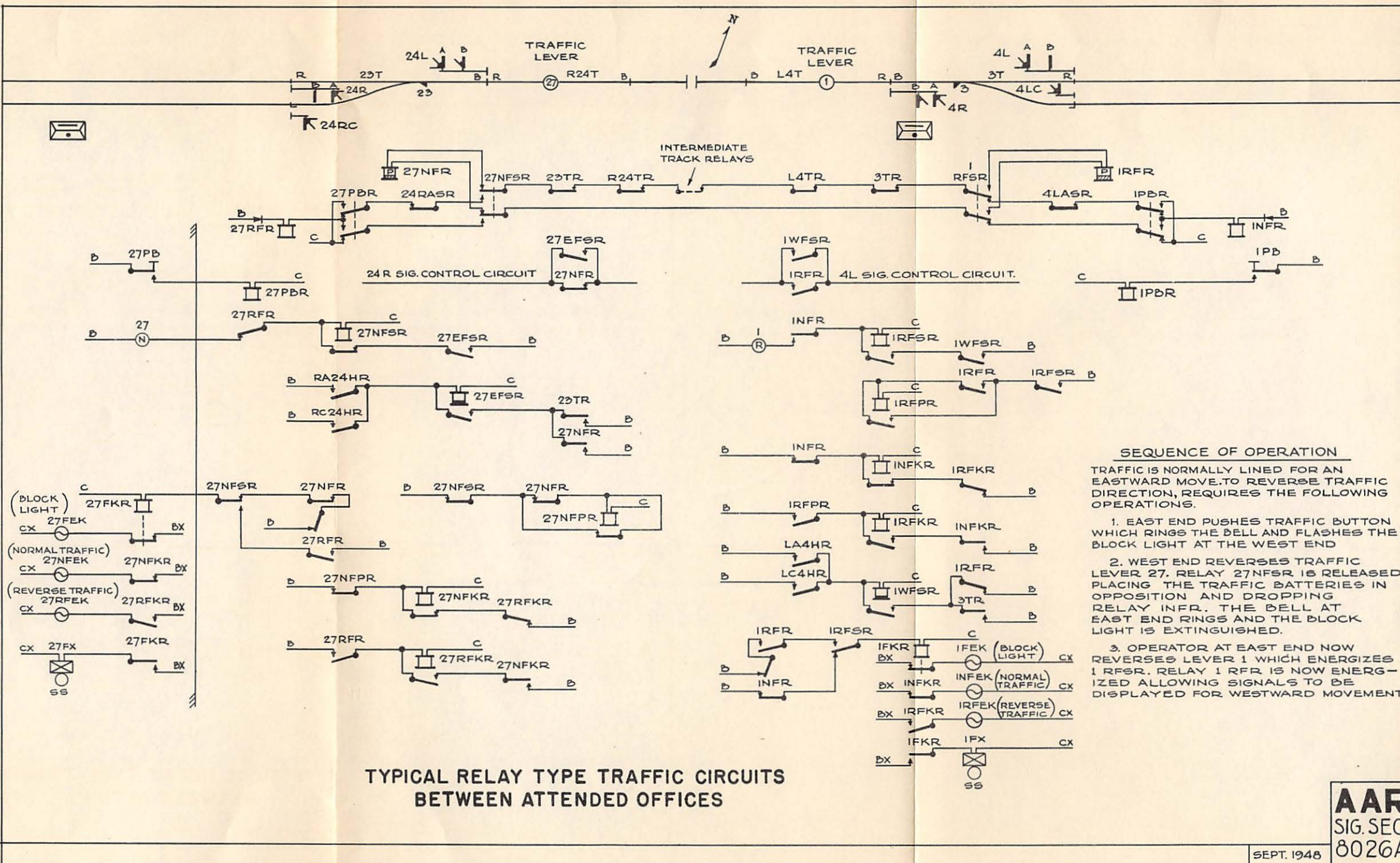
- Example 1:** Inputs Y and G are connected to RG and RY respectively. Output 2ADGP is connected to C.
- Example 2:** Inputs Y and G are connected to RG and RY respectively. Output 2CHGP is connected to C.
- Example 3:** Inputs Y and G are connected to RG and RY respectively. Output 2RGP is connected to C.
- Example 4:** Inputs Y and G are connected to RG and RY respectively. Output 4DGP is connected to C.
- Example 5:** Inputs Y and G are connected to RG and RY respectively. Output 3DGP is connected to C.

Figure 1 is a schematic diagram of a 12-channel relay assembly. It consists of 12 horizontal lines representing relay channels, grouped into four sets of three. Each set has a common line (B) and two individual lines (C). The channels are labeled with relay types and counts: 23TR, 25TR, 25WSR, 25TR, A25TR, 2TR, 4A, 4AR; 10TR, 12TR, 2TPR, 2A, 2AR, N2A; 03TR, 3TPR, 3A, 3AR, N3A; 05TR, 3TR, 5A, 5AR, N5A. A switch labeled 'B' is shown in the first set, and a switch labeled 'C' is shown in the second set.

Diagram showing two parallel transmission lines, B and C, with various components labeled. Line B has a 2TR component, followed by a 3TR component, and then a 3TP component. Line C has a 2TP component, followed by a 2TPR component, and then a 3TPR component. The components are connected by vertical lines.

3-5RK 3RGPR 5RGPR
 C T E
 2-4RK 2RGPR 4RGPR
 C T E

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SIG. SEC
8028 A



SIGNAL SECTION A.A.R.

ADVANCE NOTICE

September 14, 15 and 16, 1948

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